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FFECT OF INTEGRATED NITROGEN MANAGEMENT ON GROWTH, YIELD AND QUALITY OF BEETROOT (BETA VULGARIS L.) CV. CRIMSON GLOBE

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ABSTRACT

Field experiment was conducted on "Effect of integrated nitrogen managment on growth, Yield and quality of beet root (Beta vulgaris L.) cv. Crimson Globe" at Instructional cum research farm, Department of Horticulture, KulbhaskarAsharam Post Graduate College Prayagraj (Allahabad) UP. During Rabi season 2023-24. The experiment was laid out in Randomized Block Design (RBD) with 10 treatments.T1(60kg N/h+012.5 t/h FYM+5 t/h Vermicompost),T2 (60kg N/h +12.5 t/hFYM+5 t/h Castor cake),T3(60kg N/h+5 t/h Vermicompost+5 t/ha Castor cake),T4(60kg N/h+12.5 t/h FYM+5 t/h Vermicompost+Seed Treatment of Anubhav Bio NPK consortium (5ml/kg) seed),T5(60kgN/h+12.5t/h FYM+5y/h Castor cake+Seed Treatment of Anubhav Bio NPK consortium (5ml/kg) seeds) T6 60kg N/h+5t/h Vermicompost+5 t/h Castor cake+Seed Treatment of Anubhav Bio NPK consortium (5ml/kg) seed),T7(30 kg N/h+12.5 t/hFYM +5t/h Vermicompost+ Seed Treatment of Anubhav Bio NPK consortium (5ml /kg) Seed),T8(30kgN/h+12.5t/h FYM +5t/h Castor cake+Seed Treatment of Anubhav Bio NPK consortium (5ml/kg)seed),T9 (30kg N/h+12.5t/h FYM+5t/h Vermicompost+Seed Treatment of Anubhav Bio NPK consortium (5ml/kg)seed),T10 (60kgN/h+25 t/h FYM(control).the result obtained from T3(60kg N/h +5t/h Vermicompost+5t/h Castor cake) are significantly and sowing the highest plant height (16.71,35.20, 35.22cm), number of leaves per(6.50, 10.68, 14.30), Fresh weight of leaves per plant(224.45g), Dry weight of leaves (13.35) .Yield attributes viz (60kgN/h+12.5t/h FYM+ 5t/h Vermicompost+Seed Treatment of Anubhav Bio NPK consortium (5ml/kg) seed) are significantly and sowing heighest Root lenght(16.23 cm) , Diameter of root(7.85cm), Freshweight of root(158.05 g), Dry weight of root/plant(18.75g), Root to shoot ratio (1.42),Yield kg/plot(21.91 t), Yield tone per hectare (28.08), Harvest index (55.68%) and quality attributes viz T7(30kg N/h+12.5t/h FYM+5t/h Vermicompost+Seed Treatment of Anubhav Bio NPK consortium (5ml/kg)seed). Ascorbic acid content(3.29 mg/100g),TSS content (8.130 brix),Total sugar content (7.61%).

Keywords : *INM, beet root, growth, yield, quality.*

INTRODUCTION

Beetroot (*Beta vulgaris L.)* and chromosome number 2n=22 is cool season root vegetable crop family_ Chenopodiaceae this crop is grow as annual for root .Beetroot is rich source of protein (1.7/100g), carbohydrates (88.0mg), calcium (200.0mg), Phosphorus (55.0mg) and vitamin _C (88.0mg leaves are rich in iron (3.1mg), vitamin A(2100LU) Nutritional value of vegetables is not only in his energy content but also present in a healthy human organism in well condition.It grows best in winter with bit warm climate in the plains of India. Good quality root,rich in sugar and intense red colour are obtained always in cool weather with a temperature range between 18.3oC to 21.1oC at a temperature range below 10oC. Heavy yields are obtained from deep rich alluvial or silt loan .it is sensitive to soil acidity and yieldsare adversely affected as the soil ph goes below 5.8.but it thrives well in alkaline soil with a phas high as 9.0 to 10.0. Soil with a pH of 6.0-7.0 is considered as ideal for beet root cultivation.Nitrogen (N) is the most abundant nutrient element taken up from soil and subsequently removed by a vegetable crop .an adequate supply of nitrogen can promote plant growth and increase crop production but excessive and inappropriate use of nitrogen fertilizer cause accumulation of compound sach as nitrate,pigments and ascorbic acids in the edible Nitrogen is crucial in nutrition of beet root.this element is required for plant growth and an important component of protein, enzyme and vitamin in plants.intendive application of fertilizer mixture can cousr excessive nitrogen in crop.the best beet seed contains adequate N reserve to sustain the plan through germination. Once the seedlings reach the cotyledon stage ,N in the soil is accessed by plant roots for leaf development.

MATERIALS AND METHODS

The experiment was carried out at instructional cum research farm. Department of Horticulture, Kulbhaskar Asharam Post Graduate Collage Prayagraj. UP. During Rabi season 2023-24. The experiment was laid out in Randomized Block Design (RBD) with 8 treatments of Replicated thrice.

Details about Treatment

S.No.	Notation	Treatments
1	T1	60kgN/h+12.5t/FYM+5t/Vermicompost
2	T2	60kgN/h+12.5t/FYM+5t/Castor cake
3	T3	60kg N/h+5t/h Vermicompost+5t/ Castor cake
4	T4	60kg N/h+12.5t/h FYM+5t/h Vermicompost +Seed Treatment of Anubhav Bio NPK consortium (5ml /kg) Seed
5	T5	60kg N +12.5t/hFYM+5t/h Castor cake+Seed Treatment of Anubhav Bio NPK consortium (5ml/ kg) Seed
6	T6	60kg N/+5t/h Vermicompost+5t/h Castor cake+ Seed Treatment of Anubhav Bio NPK consortium (5ml/ kg) Seed
7	T7	30kg N/h+12.5t/hFYM+ 5t/h Vermicompost+ Seed Treatment of Anubhav Bio NPK consortium (5ml/ kg) Seed
8	T8	30kg N/h+12.5t/h FYM+5t/ h Castor cake+ Seed Treatment of Anubhav Bio NPK consortium (5ml/ kg) Seed
9	T9	30kg N/h+5t/h Vermicompost+5t/h Castor cake+Seed Treatment of Anubhav Bio NPK consortium (5ml/ kg) Seed
10	T10	60kgN/h+25t/h FYM (control)

There were altogether 30 plots each of 3.3 x2.7m2 size. Seed sowing was done on16 November 2023 with spacing 30 x 10 cm. During the life cycle of the plants, hoeing, weeding and irrigation were provided at proper time so as facilitate better growth and development of crop. The observation was recorded i.e Plant height (cm), Number of leaves, Fresh weight of leaves, Dry weight of leaves, Root length(cm).Root diameter (cm),Fresh weight of root(g), Dry weight of root (g),Root to shoot ratio, yield(kg/plot), Yields (t/h), Harvest index(%), Ascorbic acid content (mg/100g) ,TSS content (o brix), Total sugar content (%).

RESULTS AND DISCUSSION

Growth parameters

Plant height (cm)

Vertical growth of the plant attained during the growing season is measured as plant height which is one of the most important indicators of plant growth and development.

At 25 DAS,50 DAS, At harvest.after seed sowing, the significantly maximum plant height was recorded T3(60 kg N/ha + 5 t/ha vermicompost +5 t/ha castor cake),(16.71),(35.20),(35.25) and lowest plant height (13.91cm),(28.27),(29.79) was recorded in T10 i.e .under control.

Number of leaves per plant

The data pertaining to number of leaves per plant, recorded at 25, 50 DAS and at harvest.the effect of different treatments on number of leaves was found to be statistically significant.

At 25DAS,50 DAS,At harvest .The treatment T 3(60 kg N/ha +5 t/ha vermicompost + 5 t/ha castor cake) recorded maximum number of leaves per plant (6.50cm),(10.6cm), (14.30cm), whereas the minimum number of leaves were observed in Control T10(5.37cm),(7.49cm), (10.65cm). Above findings are in agreement with Jagadeesh (2018) in beet root, Jabeen et al. (2017) in spinach beet and Pawar (2010), Chauhan (2015), Mehwish et.al.(2016) in carrot.

Fresh weight of leaves (with petiole) (g)

The maximum Fresh weight of leaves was recovered in T3 (60 kg N/ha + 5 t/ha Vermicompost +5 t/ha Castor cake),(224.45g). And lowest fresh weight of leaves T10(60kgN/h+25 t/h FYM).content in the plant which leads to the increase in the chlorophyll content of leaf and ultimately increases the fresh weight of leaves. Better availability of nutrients and the balanced C/N ratio might have increased synthesis of higher chlorophyll index the results are comparable with those of Singh et al. (2017), Kirad et al. (2010) in carrot and Khalid et al. (2015) in radish.

Root length (cm)

The data pertaining to root length was recorded to be higher in treatment T4 (60 kg N/ha+ 12.5 t/ha FYM + 5 t/ha Vermicompost +Seed treatment of Anubhav Bio NPK consortium (5 ml/kg seed) (16.23 cm.) it might be due to better plant growth in all aspects resulted in more Translocation of photosynthates from leaves (source) to root (sink), led to increased root length. Similar results were also reported by Singh et.al. (2017), Kirad et. al. (2010) as well as Vithwel and Kanaujia (2013) in carrot.

Root diameter (cm)

The data with respect to root diameter of beet root plant at harvest Was significantly influenced due to different treatment T4[60 kg N/ha +12.5 t/ha FYM +5 t/ha Vermicompost +Seed treatment of Anubhav Bio NPK consortium (5 ml/kg seed)) recorded the maximum root diameter (7.85 cm) and respectively while it was

Fresh weight of root

Significantly the maximum root weight (198.05 g) was recorded with treatment T4 i.e.60 kg N/ha +12.5 t/ha FYM+ 5 t/ha Vermicompost +Seed treatment of Anubhav Bio NPK consortium (5 ml/kg seed) and it was statistically superior over all other remaining treatments. Whereas the minimum root weight (114.49 g) was recorded in treatment T10£ i.e.60 Kg N/ha 25 t/ha FYM (control).The results are comparable with the reports of Vithwel and Kanaujia (2013) in carrot and Khalid et.al (2016) in radish .Similar findings are also in agreement with Kushwah (2015) in carrot and Jadhav et al. (2014), Kumar et .al. (2014) in radish.

Dry weight of root (g)

Significantly the maximum dry weight of roots (18.75 g) was noted with treatment T4 i.e. 60 kg N/ha+ 12.5 t/ha FYM +5 t/ha Vermicompost +Seed treatment of Anubhav Bio NPK consortium (5 ml/kg seed) and it was statistically significant over all other remaining treatments. On the other hand the minimum root weight (10.42 g) was recorded in T10 with 60 kg N/ha + 25 t/ha FYM (control).

Root to shoot ratio

The highest root-shoot ratio of 1.42 was recorded with treatment T4 i.e. 60 kg N/ha 12.5 t/ha FYM +5 t/ha Vermicompost +Seed treatment of Anubhav Bio NPK consortium (5 ml/kg seed).Similar findings have also been reported by Indikumari Dev et. al. (2016), Wael et. al. (2015) and Khalid et. al. (2015).

Yield (kg/plot)

The highest yield (21.91 kg of beet root) was recorded in T4, i.e. Application of 60 kg N/ha +12.5 t/ha FYM+ 5 t/ha Vermicompost +Seed Treatment of Anubhav Bio NPK consortium (5 ml/kg seed) Significantly superior to all other treatments whereas the lowest root yield (15.06 kg) was recorded in treatment T10, i.e. 60 kg N/ha +25 t/ha FYM (control).

Yield(t/h)

The highest root yield (28.08 t/ha) was recorded in T4 (60 kg N/ha + 12.5 t/ha FYM+ 5 t/ha Vermicompost +Seed treatment of Anubhav Bio NPK consortium (5 ml/kg seed)) which was significantly superior over all other treatments.

Table - 1 : Effect of integrated nitrogen management on growth,yield and quality of beet root.

	Plant height(cm)			Plant height(cm)					
Treatment	25DAS	50DAS	At harvest	25DAS	50DAS	At harvest	Fresh w.of leaves(g)	Root leangth(cm)	Root diameter (cm)
T_1	14.48	29.45	30.90	5.31	7.82	10.79	177.20	15.74	7.42
T_2	16.02	33.89	34.10	6.19	10.35	13.8	148.44	14.52	6.95
T_3	16.71	35.20	35.25	6.50	10.68	14.30	224.45	14.38	6.93
T_4	16.68	34.20	34.64	6.24	10.44	14.15	198.88	16.23	7.85
T_5	15.40	32.55	32.98	5.77	8.62	11.81	147.84	14.74	7.06
T_6	14.67	29.23	31.19	5.59	7.95	10.95	125.16	14.56	7.02
T_7	15.20	15.24	32.88	5.79	8.38	11.38	135.81	15.78	7.55
T_8	14.80	31.68	31.89	5.67	8.29	11.29	131.81	15.06	7.31
T_9	15.45	32.51	33.10	5.82	8.90	12.22	147.94	13.93	6.50
T_{10}	13.91	28.27	29.79	5.27	7.49	10.65	103.39	13.49	6.04
SE(m)	0.44	0.85	0.75	0.22	0.61	0.72	6.33	30.39	0.17
CD5%	1.25	2.42	2.14	0.65	1.75	2.06	18.02	1.12	10.49
CV(%)	4.97	4.61	3.98	6.80	11.97	10.32	7.40	4.59	4.22

Table - 2 : Effect of integrated nitrogen management on growth,yield and quality of beet root.

Treatment	Fresh w.of root	Dry w.of root(g)	Root to shot ratio	Yield(kg/p)	Yield(t/h)	Harvest index(%)	TSS content(°brix)	Total sugar(%)
T_1	169.06	16.93	1.35	19.75	25.32	54.18	7.37	6.49
T_2	146.05	12.19	1.14	18.26	23.41	50.89	7.45	6.72
T_3	135.58	11.14	1.09	17.64	22.61	49.72	7.95	6.96
T_4	158.05	18.75	1.42	21.91	28.08	55.68	7.40	6.60
T_5	158.63	14.59	1.18	18.40	23.58	52.02	7.07	6.39
T_6	146.11	12.74	11.16	18.31	23.47	51.12	8.10	7.26
T_7	180.99	17.00	1.35	19.81	25.39	54.49	8.13	7.61
T_8	163.17	16.69	11.27	18.66	23.92	52.59	7.57	6.76
T_9	127.65	10.95	10.97	16.90	21.66	44.74	7.43	6.70
T_{10}	114.49	10.42	0.86	15.06	19.30	38.93	6.47	6.09
SE(m)$\pm$	4.19	0.35	0.03	0.71	0.91	0.93	0.06	0.22
CD5%	11.94	1.02	0.09	2.02	2.58	2.76	0.19	0.63
CV (%)	4.71	4.38	4.64	6.66	6.64	3.33	1.52	5.68

Whereas, the treatment T10(60 kgN/ha+ 25 t/ha FYM) registered the lowest root yield (19.30 t/ha).Simila findings with the application of organics were observed by Kamla Singh (2000) in the tuber yields of potato.

Harvest index (%)

The highest harvest index (55.68) was recorded with treatment T4, (60 kg N/ha+ 12.5 tha FYM+ 5 t/ha Vermicompost +Seed treatment of Anubhav Bio NPK consortium (5) ml/kg seed) .while the lowest harvest Index (38.93%) was observed with T10 i.e. application of 60 kg N/ha + 25 t/ha FYM (control). The results are similar to the Findings of Jagdeesh et.al. (2018), Mbithi et al. (2015).

TSS Content (°Brix)

Significantly the maximum TSS (8.13 "Brix) was recorded with treatment T7 (30 kg N/ha +12.5 t/ha FYM +5 t/h Vermicompost+ Seed treatment of Anubhav Bio NPK consortium (5 ml/kg seed) .The lowest TSS content (6.47 "Brix) was recorded in T10 e.t.control (60 kg N/ha + 25 t/h FYM (control).

Total sugar content (%)

The highest total sugar content (7.61%) was recorded in T7 (30 kg N/ha +12.5 t/ha FYM + 5 t/ha Vermicompost + Seed treatment of Anubhav Bio NPK consortium (5 ml/kg seed) .Whereas the lowest total sugars content (6.09%) Was recorded with T10(control)

CONCLUSION

It could be concluded from the present investigation that, the integrated Nitrogen management significantly effect the growth, yield and quality of beet root cv. (Crimson globe). Among the different levels of integrated nitrogen management optimum growth, yield and quality was obtained from T_4 [60kg N/h+ 5t/h Vermicompost+seed treatment of Anubhav Bio NPK consortium (5ml/kg seed) give the highest root yield.

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EFFECT OF INTEGRATED NUTRIENT MANAGMENT ON GROWTH, YIELD AND QUALITY OF CARROT (DAUCUS CAROTA L.) CV. CARROT FLORANCE

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ABSTRACT

A field experiment was conducted on "Effect of integrated nutrient managment on growth, yield and quality of carrot (*Daucus carota L.*) cv. carrot florance" at Instructional cum research farm, Department of Horticulture, Kulbhaskar Ashram Post Graduate College Prayagraj (Allahabad) UP. During Rabi season 2023-24. The experiment was laid out in Randomized Block Design (RBD) with 8 treatments $T_{1(}$Control) , T_2 {100% RDF(100:50:50 kg/ha N: P: K, respectively)}, T_3(Neem cake 50% + Vermicompost 50%), T_4(Neem cake 50% + Poultry manure 50%), T_5(Neem cake 50%+FYM 50%), T_6(Neem cake 25%Vermicompost 25% + FYM 25%+ Poultry manure 25%), T_7[RDF 50% + 50% (Neem cake 12.5% + Vermicompost 12.5% + FYM 12.5%+ Poultry manure 12.5%)], T_8 [RDF 75% + 25% (Neem cake 6.25% + Vermicompost 6.25% + FYM 6.25%+ Poultry manure 6.25%)]. The result obtained from T_8 [RDF 75% + 25% (Neem cake 6.25% + Vermicompost 6.25% + FYM 6.25%+ Poultry manure 6.25%)] are significantly and sowing the highest plant height (47.40, 48.00, 40.20cm), number of leaves per(7.98, 11.14, 12.80, 14.65), Fresh weight of leaves per plant(96.82g), Dry matter of leaves(8.46%), Root length(20.55cm), Diameter of root(7.21cm), Dry matter of root(10.38%), Fresh weight of root/plant(125.65g), Gross yield of root per plot (5.50kg), Root cracking(3.55%), Root rotting(3.25%), Total soluble salt (8.63"Brix), Vitamin A content(1110 IU/100g).

Keywords : *INM, carrot, growth, yield , quality, biofertilizer.*

INTRODUCTION

Carrot (*Daucus carota L). and* chromosome number 2n =18 is a cool season root vegetables belong to Umbelliferae family. Carrot has high nutritional and medicinal benefits. The genus *Daucus* to which the carrot belongs to about 50 species. Carrot has a main tap-root which becomes tuberous with absorbent hairs but without secondary roots. The roots may grow up to 20 cm in length and attain a diameter of 3-4 cm. It is made up of a central cylinder which is more or less fibrous and external part have deeper color. Wild carrot (subspecies *D.*

carota, also called Queen Anne's lace) is native to Eurasia and is thought to have been domesticated in Central Asia around 1000 CE. Carrot is generally grown in all over the world in temperate during spiting, summer and autumn, while in tropical and sub-tropical in winter. Carrot is said to be the native of North and South America. The first carrot types were purple or violet, yellow and later orange types were derived from this anthocyanin type by selection from tiny white or pinkish flowers are borne on large compound clusters (umbels) at the ends of the main stalk and branches. The spiny seeds are produced in small segmented fruits called schizocarps. Fresh carrots should be firm and crisp, with smooth and unblemished skin. Bright-orange color indicates high carotene content, smaller types are the tenderest . Carrot is a biennial but grown as an annual crop, characterized by relatively moderate requirement for soil and climate. For the ideal growth and development of carrot. It requires a deep well drained loose loamy soil the best pH of soil 6.6 to 7.1. Soil pH more or less than above range it will lead to reduction in quality and yield of carrot China currently leads the world in production and consumption of carrot, repressing about 45% of global market for this commodity. In India carrot was reported at 114000 ha. In 2019 with an annual production of 1865000 tons. Integrated nutrient management (INM) is a better approach for supplying nutrition to the crop by including organic and inorganic sources of nutrients. However, continuous dependence on chemical fertilizers causes nutritional imbalance and adverse effects on physio-chemical and biological properties of the soil. Thus, a combined use of organic manures, biofertilizers with a reduced dose of chemical fertilizers, not only pave the way for higher yield and quality produce but also help to maintain the soil health and reduce pollution problems.

MATERIALS AND METHODS

The experiment was carried out at instructional cum research farm, Department of Horticulture, Kulbhaskar Ashram Post Graduate Collage Prayagraj, UP. During Rabi season 2023-24. The experiment was laid out in Randomized Block Design (RBD) with 8 treatments of replicated thrice.

S.no.	Notation	TREATMENT
1.	T_1	Control
2.	T_2	100% RDF(100:50:50 kg/ha N: P: K, respectively)
3.	T_3	Neem cake 50% + Vermicompost 50%
4.	T_4	Neem cake 50% + Poultry manure 50%
5.	T_5	Neem cake 50%+FYM 50%
6.	T_6	Neem cake 25% + Vermicompost 25% + FYM 25%+ Poultry manure 25%
7.	T_7	RDF 50% + 50% (Neem cake 12.5% + Vermicompost 12.5% + FYM 12.5%+ Poultry manure 12.5%)
8.	T_8	RDF 75% + 25% (Neem cake 6.25% + Vermicompost 6.25% + FYM 6.25%+ Poultry manure 6.25%)

There were altogether 30 plots each of 3.3 ×2.7m2size. Transplanting was done on 25 october 2023 with spacing 30 x 10 cm. During the life cycle of the plants, hoeing, weeding and irrigation were provided at proper time so as facilitate better growth and development of crop. The observation was recorded i.e Plant height (cm),Number of leaves, Fresh weight of leaves, Dry matter of leaves, Root length(cm), Fresh weight of root(g), Gross yield, Root cracking, Root rotting(%), TSS(brix), Vitamin A (IU/100).

RESULTS AND DISCUSSION

Growth parameters

Plant height (cm)

The plant height was recorded at different stages of growth i.e. 45, 60, 75 and 90 (DAS). The plant height varied significantly due to the application of different levels of NPK,FYM, VC,PM,NM during the period of plant growth, the highest plant height was observed in treatment T_8 [RDF 75% + 25% (Neem cake 6.25% + Vermicompost 6.25% + FYM 6.25%+ Poultry manure 6.25%)] was (28.40, 44.30, 47.40, 48.00). The findings are in agreement with the findings of Sunandarani and Mallareddy (2007), Vijayakumari *et al.,* (2009), Kirad *et al.,* (2010), Jeptoo *et al.,* (2013) and Ali *et al.,* (2014) in carrot Mhithi *et al.,* (2015) in beet root,Uddain *et al.,* (2010), Kumar *et al.,* (2014) in radish and Yanthan *et al.,* (2012) in turnip.

Number of leaves per plant

A significant variation was found due to application of different levels of nitrogen, phosphorus and potassium on number of leaves per plant. Result was sowing the highest number of leaves was obtained from T_8. [RDF 75% + 25% (Neem cake 6.25% + Vermicompost 6.25% + FYM 6.25%+ Poultry manure 6.25%)] is (7.98, 11.14, 12.80, 14.65).Above findings are in agreement with Jabeen *et al.,* (2017) in spinach beet and Pawar (2010), Chauhan (2015),Mehwish *etal.,* (2016) in carrot. Jagadeesh (2018) in beet root.

Fresh weight of leaves per plant (g)

The fresh weight of leaves per plant varied significantly due to the application of different levels of nitrogen, phosphorus and potassium, FYM etc. the highest fresh weight of leaves per plant was observed in treatment T_8[RDF 75% + 25% (Neem cake 6.25% + Vermicompost 6.25% + FYM 6.25%+ Poultry manure 6.25%)] which was (96.82g).

Dry matter of leaves (%)

The maximum dry matter of leaves 8.46% was recorded with T_8 (RDF 75% + 25% (Neem cake 6.25% + Vermicompost 6.25% + FYM 6.25%+ Poultry manure 6.25%)), which was found to be significantly.The results are in line with the Jeptoo *et al.,* (2013) in carrot.

YIELD CHARACTERS

Root length (cm)

The maximum root length 20.55cm was recorded with T_8 (RDF 75% + 25% (Neem cake 6.25% + Vermicompost 6.25% + FYM 6.25%+ Poultry manure 6.25%)).The organic nutrient source, particularly vermicompost improves the soil structure and soil quality which might have resulted increase in rond length. These findings are in accordance with the results of reseicth conducted by Vijayalomari *et al.,* (2009), Vithwel and Kananjia (2013) in carrot, Asghar *et al.,* (2006) and Uddain *et al.,* (2010) in radish.

Diameter of root (cm)

The perusal data revealed different doses of INM significantly affected the diameter of root (cm) after harvest. The maximum diameter of root 7.21cm was recorded with T_8 (RDF 75% + 25% (Neem cake 6.25% + Vermicompost 6.25% + FYM 6.25%+ Poultry manure 6.25%)), which was found to be significantly. Similar type of findings was also reported by Vithwel and Kanaujia (2013), Rani *et al.,* (2006) in carrot as well as Kumar *et al*., (2014) in radish.

Dry matter of root (%)

The maximum dry matter of root 10.38% was recorded with T_8 (RDF 75% + 25% (Neem cake 6.25% + Vermicompost 6.25% + FYM 6.25%+ Poultry manure 6.25%)), which was found to be significantly.

Fresh weight of root/plant (g)

The maximum fresh weight of root per plant 125.65g was recorded with T_8 [(RDF 75% + 25% (Neem cake 6.25% + Vermicompost 6.25% + FYM 6.25%+ Poultry manure 6.25%)], which was found to be significantly. Our results are comparable with the reports of Vithwel Kanaujia (2013) in carrot and Khalid *et al.,* (2015) in radish.

Gross yield of root/ plot (kg)

The perusal data revealed different doses of INM significantly affected the gross yield of root/ plot (kg) after harvest. The maximum the gross yield of root/ plot 5.50kg was recorded with T_8 (RDF 75% + 25% (Neem cake 6.25% + Vermicompost 6.25% + FYM 6.25%+ Poultry manure 6.25%)].Similar findings are also in agreement with Kushwah (2015) in carrot and Jadhav *et al.,* (2014), Kumar *et al.,* (2014) in radish.

Gross yield of root (t/ha)

The perusal data revealed different doses of INM significantly affected the gross yield of root (t/ha) after harvest. The maximum gross yield of root (t/ha) 37.85 was recorded with T_8 (RDF 75% + 25% (Neem cake 6.25% + Vermicompost 6.25% + FYM 6.25%+ Poultry manure 6.25%)which was found to be significantly.

QUALITATIVE CHARACTERS

Root cracking (%)

The highest cracking percentage of roots (4.44%) was recorded in control treatment (T_1) whereas, the lowest cracking percentage (3.55%) was observed in T8 (RDF 75% + 25% (Neem cake 6.25% + Vermicompost 6.25% + FYM 6.25%+ Poultry manure 6.25%), which was found to be significantly. The results are in accordance with that of Mehedi *et al.,* (2012) in carrot.

Root rotting (%)

The highest rotting percentage of roots (3.88%) was recorded in control treatment (T_1) whereas, the lowest rotting percentage (3.25%) was observed in T_8 (RDF 75% + 25% (Neem cake 6.25% + Vermicompost 6.25% + FYM 6.25%+ Poultry manure 6.25%)), which was found to be significantly.

Total soluble salt ("Brix)

The perusal data revealed different doses of INM significantly affected the TSS ("Brix) after lab tested was found. The maximum TSS (Brix) 8.63 was recorded with T_8 RDF 75% + 25% (Neem cake 6.25% + Vermicompost 6.25% + FYM 6.25%+ Poultry manure 6.25%)), which was found to be significantly.Similar findings are in line with findings of Szopinska and Gaweda (2013), Jagadeesh *et al., (*2018) in beet root and Rani *et al., (*2006), Sunandarani and Mallareddy (2007), Kumar (2013), Sarma *et al.,* (2015) in carrot.

Vitamin A content (IU/100g)

The perusal data revealed different doses of INM significantly affected the Vitamin A content (IU/100g) after lab tested was found. The maximum A content (IU/100g) 1110 was recorded with T_7 (RDF 75% + 25% (Neem cake 6.25% + Vermicompost 6.25% + FYM 6.25%+ Poultry manure 6.25%)), which was found to be significantly.

Table - 1 : Effect of integrated nutrient management on growth, yield and quality of carrot

Treatment	Plant height (cm)				Number of leaves per plant				Fresh Wt. of leaves (g)	Dry matter of leaves(%)
	45 DAS	60 DAS	75 DAS	90 DAS	45 DAS	60 DAS	75 DAS	90 DAS		
T_1	17.32	25.70	33.40	34.60	7.20	7.57	8.04	10.92	74.40	6.88
T_2	18.40	32.83	41.23	41.47	7.32	8.50	9.90	12.05	76.50	6.27
T_3	21.20	33.40	42.17	42.39	7.51	8.83	12.10	12.92	81.77	7.15
T_4	22.50	34.83	42.62	42.98	7.47	8.71	11.05	13.62	82.56	6.40
T_5	18.50	31.50	45.41	45.68	7.66	9.16	10.42	12.81	87.64	6.73
T_6	26.40	39.30	43.44	43.55	7.67	9.19	12.60	13.63	86.71	7.19
T_7	27.20	40.20	46.20	46.40	7.70	8.89	12.15	14.50	93.45	8.37
T_8	28.40	44.30	47.40	48.00	7.98	11.14	12.80	14.65	96.82	8.46
SE(m)±	**0.09**	**0.09**	**0.10**	**0.10**	**0.05**	**0.02**	**0.02**	**0.02**	**0.05**	**0.04**
CD 5%	**0.27**	**0.28**	**0.29**	**0.29**	**0.15**	**0.07**	**0.07**	**0.07**	**0.15**	**0.13**

Table - 2 : Effect of integrated nutrient management on growth, yield and quality of carrot

Treatment	Root length (cm)	Diameter of root (cm)	Dry matter of root (%)	Fresh weight of root/plant (g)	Gross yield of root/ plot (kg)	Gross yield of root (t/ha)	Root cracking (%)	Root rotting (%)	Total soluble salt ("Brix)	Vitamin A content (IU/100g)
T_1	11.14	4.85	5.22	90.40	3.04	25.00	4.44	3.88	7.23	890.00
T_2	11.56	5.25	8.61	104.15	4.15	34.00	4.53	3.56	7.53	950.00
T_3	11.65	5.50	8.83	108.15	4.32	34.50	4.49	3.32	7.89	980.00
T_4	12.63	5.62	8.42	92.04	4.46	36.01	4.40	3.29	7.45	895.00
T_5	10.63	4.97	9.45	101.20	3.70	35.10	4.32	3.34	8.44	1050.00
T_6	10.57	6.01	9.77	120.30	4.67	33.22	4.20	3.30	7.65	1044.00
T_7	19.58	6.75	10.35	111.56	4.69	36.57	3.85	3.40	8.60	1110.00
T_8	20.55	7.21	10.38	125.65	5.50	37.85	3.55	3.25	8.63	980.00
SE(m)±	**0.01**	**0.04**	**0.01**	**0.05**	**0.03**	**0.08**	**0.04**	**1.03**	**0.01**	**2.04**
CD 5%	**0.03**	**0.04**	**0.01**	**0.05**	**0.10**	**0.08**	**0.12**	**0.06**	**0.00**	**6.19**

CONCLUSION

It could be concluded from the present investigation that, the integrated nutrient management significantly influenced the growth, yield and quality of carrot cv. (Carrot inflorance). Among the different levels of integrated nutrient management optimum growth, yield and quality was obtained from T_8[RDF 75% + 25% (Neem cake 6.25% + Vermicompost 6.25% + FYM 6.25%+ Poultry manure 6.25%)].

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EFFECT OF NANO UREA AND CCC ON GROWTH, YIELD AND QUALITY OF TOMATO (SOLANUM LYCOPERSICUM L.) CV. NARENDRA TOMATO - 1

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ABSTRACT

The present study was conducted at the Kulbhaskar Ashram Post Graduate College, Prayagraj during rabi season of the year 2023-24. Plant material consisted of 11 treatments of tomato in randomized block designof3x3m^{2}spacingwiththreereplications. Evaluation was done for Effect of nano urea and PGR on growth, yield and quality of tomato *(Solanum lycopersicum L.)* cv.Narendra Tomato-1. In resultstreatment T_7(50% N of RDF as prilled urea +4% nano urea + 200 PPM CCC at 30 and 60 DAT) showed superior result for Number of branches plant-1(1.72, 3.53, 6.32, 14.80, 24.69), Number of leaves plant-1 (6.55, 16.66, 50.78, 70.17, 76.84), Leaf area plant-1 (170.27, 207.79, 288.00, 335.27, 359.26), Number of flower cluster plant-1(28.40), Number of fruit plant-1 (47.00), Polar diameter of fruit (5.32cm), Equatorial diameter of fruit (5.07cm), Fresh weight of fruit (65.5g), Dry weight of fruit (3.90g), Fruit yield (19.8kg/plot), Fruit yield (270.00 q/ha), Shelf life of fruit (13.35 days at room temperature), TSS (4.90°Brix) and Acidity (0.75%) and T_1 (100% RDF (100:80:60) kg / ha) gave significant best result for plant height (38.22, 47.04, 71.62, 95.20, 113.38 cm), Days to 1st flowering (42.39 DAT), Days to 50% flowering (53.25 DAT) and Days to first fruit picking (83.00 DAT) thatis significantly superior to other treatments.

Keywords : *CCC, tomato, nano urea, growth, yield, quality.*

INTRODUCTION

Tomato is one of the most popular vegetables grown all over the world. In India, tomato has wider coverage in comparison to other vegetables. Scientific information indicates that the cultivated tomato originated in a wild form in the Peru- Ecuador - Bolivia area of the Andes (South America). *Tomato (Solanum lycopersicum L.)* is an herbaceous annual perennial prostrate and sexually propagated plant and it have chromosome number 2n=2X=24. Tomato is a very remunerative crop for small and marginal farmers. Tomato is used directly as raw vegetable in sandwiches, salad etc. and several processed products like paste, puree, soup, ketchup, drinks; whole peeled tomatoes, sauces and chutney are prepared on large scale. The pulp and juice are digestible, a promoter of gastric secretion and blood purifier. Tomato is a good source of vitamins, ascorbic acid and vitamins C, vitamin A, thiamine or vitamin B1 and riboflavin or vitamin B2 in that order. A 100 g edible portion of tomato contains 94.1 g water, 1 g protein, 0.3 g fat, 4 g carbohydrates. (Thamuraj and Singh 2012)

The cultivated tomato has an estimated global production of over 193 million tonnes. Major tomato-producing countries are China, USA, India, Turkey, Egypt and Italy. India ranks second in the area as well as in the production of tomatoes next to China. In India, tomato occupies an area of 8.40 lakh ha, production of 20.35 mt and productivity of 24.19 t/ha. (Annoy 2022-23).Tomato shows better growth in well-drained, sandy or red loam soils rich in organic matter with a pH range of 6.0-7. Tomato is a warm-season crop. The best fruit colour and quality is obtained at a temperature range of 21-24°C. Temperatures above 32°C adversely affect the fruit set and development.

Nano urea is more efficient and effective than conventional fertilizers because of their positive effects on the quality of food crops, reduced stresses that occur to the plant, small applied quantities and costs, fast absorption by plant cells penetration of cells and fast transport and representation within plant tissue. Nano urea has higher transport and delivery of nutrients through plasmodesmata, which are nano-sized (50–60 nm) channels between cells. The higher nutrient use efficiency and significantly lesser nutrient losses of nano urea led to higher productivity (6–17%) and nutritional quality of field crops.

Tomato is a frosting-prone crop. The autumn/winter cultivation of tomatoes is greatly affected by low temperatures. Extreme cold during Dec -Jan greatly hampered the growth of tomato plants and also caused fungal attacks that destroyed the crop. To protect tomato crops from frost application of plant growth regulators today has been proven a boon to tomato cultivation. Cycocel (CCC) is an important PGR spray of 200 PPM in tomatoes found to increase resistance to low temperatures. CCC application also gain resistant to blight and verticillium rot disease.

MATERIALS AND METHODS

The experiment was conducted at the farm of Department of Horticulture, Kulbhaskar Ashram Post Graduate College, Prayagraj, Uttar Pradesh during rabi season 2023-2024. The experiment was laid out with 11 treatments of tomato in randomized block designof60x60cm^2 spacing with threer eplications and the plot size it 3x3m^2.

Table - 1 : Details of treatment combinations

Notation	Treatment
T1	(Control) 100% RDF (100:80:60) kg / ha
T_2	25% N of RDF as prilled urea +4% nano urea at 30 and 60 DAT
T_3	25% N of RDF as prilled urea +4% nano urea at 30,45 and 60 DAT
T_4	25% N of RDF as prilled urea +4% nano urea + 200 PPM CCC at 30 and 60 DAT
T_5	50% N of RDF as prilled urea +4% nano urea at 30 and 60 DAT
T_6	50% N of RDF as prilled urea +4% nano urea at 30,45 and 60 DAT
T_7	50% N of RDF as prilled urea +4% nano urea + 200 PPM CCC at 30 and 60 DAT
T_8	75% N of RDF as prilled urea +4% nano urea at 30 and 60 DAT
T_9	75% N of RDF as prilled urea +4% nano urea at 30, 45 and 60 DAT
T_{10}	75% N of RDF as prilled urea +4% nano urea + 200 PPM CCC at 30 and 60 DAT
T_{11}	100% N of RDF as prilled urea + 4% nano urea at 60 DAT

Transplanting was done on 14/11/2023 in main field. During the life cycle of the plants, hoeing, weeding and irrigation were provided at proper time so as facilitate better growth and development of crop. The observation was recorded i.e. Plant height (cm), Number of branches per plant, Number of leaves per plant, Leaf area (cm^2), Days to first flowering, Days to 50% flowering, No of flower cluster per plant, First picking of fruit, fresh weight of fruit(g), dry weight of fruit(g), polar diameter of fruit(cm), equatorial diameter of fruit (cm), Number of fruits per plant, fruit yield (kg/plot), fruit yield (q/ha), Shelf life of fruit at room temperature, TSS (^{o}Brix), Acidity (%).

RESULTS AND DISCUSSION

Growth Parameters

Observations on plant height, number of branches per plant, number of leaves per plant, leaf area were recorded at different stages of growth, are presented as follows:

Plant height (cm)

The significantly maximum plant height 38.22,47.04,71.62,95.20,113.38 were recorded in treatment T1 [(Control) (100% RDF)] at all DAT and at harvest), followed by T7 (50% N of RDF +4% nano urea + 200 PPM CCC at 30 and 60 DAT) (35.72, 46.03, 70.26, 93.11, 110.47) at all DAT and at harvesting respectively. A comparable result was reported by Chattarjje*et al.,* (2014).

Number of branches/plants

The significantly maximum number of branches per plant i.e. 1.72, 3.53, 6.32, 14.80, and 24.69 were observed under the treatment T7 (50% N of RDF +4% nano urea + 200 PPM CCC at 30 and 60 DAT). followed by T1 [(Control) (100% RDF)] 1.64, 3.42, 6.04, 13.68 and 21.92 branches per plant at all DAT and at harvest. The results of the study are similar with Siddaling et al., (2017).

Number of leaves /plants

The significantly maximum 6.55, 16.66, 50.78, 70.17 and 76.84 leaves per plant were found under the treatment T7 (50% N of RDF +4% nano urea + 200 PPM CCC at 30 and 60 DAT) followed by T1[(Control) (100% RDF)] 6.35, 15.10, 49.00, 67.75 and 76.76 leaves per plant at all DAT and at harvest treatment T7 was found at par with T1. This result was supported by the finding of Islam *et al.,* (2013).

Leaf area per plant (cm^2)

Treatment T7 (50% N of RDF +4% nano urea + 200 PPM CCC at 30 and 60 DAT) was observed the significantly highest 170.27, 207.97, 288.00, 335.27 and 359.26cm2 leaf area per plant and was superior over DAT (20, 40, 60, 80,120) and at harvest followed by T1 [(Control) (100% RDF)] 165.27, 199.97, 276.32, 326.15 and 335.30 leaf area per plant at all DAT and at harvest. The results are in the close agreement with Gosavi *et al.,* (2010). and Siddaling*et al.,* (2017).

Phenological parameters: -

Number of flower cluster / plant

The significantly maximum number of flowers was recorded in the treatment T7 (50% N of RDF +4% nano urea + 200 PPM CCC at 30 and 60 DAT). valued 28.40 followed by T1 [(Control) (100% RDF)] valued 27.72 both were at par with each other. The similar result reported by Singh et al., (2017).

Days to first flowering

The significantly minimum days taken into first flowering was recorded in the treatment T1 [(Control) (100% RDF)] valued 42.39 followed by T7 (50% N of RDF +4% nano urea + 200 PPM CCC at 30 and 60 DAT) Valued 42.22. Similar results have been reported by Laxmi *et al.,* (2015), Parmar *et al.,* (2019).

Days to 50% flowering

The minimum days taken to 50% flowering

was recorded in the treatment T1[(Control) (100% RDF)] valued 53.25 followed by T7 (50% N of RDF +4% nano urea + 200 PPM CCC at 30 and 60 DAT) valued 54.39. The findings are in agreement with findings of Parmar et al., (2019).

Days to first fruit picking

The treatment T1 (100% RDF) resulted in the shortest period taken to first fruit picking in tomato valued 83.00 which is followed by T7 (50% N of RDF +4% nano urea + 200 PPM CCC at 30 and 60 DAT). valued 84.00. Similar results were also declared by Chatterjee et al., (2014-15), Parmar et al., (2019).

Number of fruits per plant

Significantly maximum no. of fruit per plant was recorded under the treatments T7 (50% N of RDF +4% nano urea + 200 PPM CCC at 30 and 60 DAT). value 47.00 Followed by T1 [(Control) (100% RDF)] valued 45.00. respectively. These results are in conformity with the findings of Singh et al., (2017), Siddaling et al., (2017).

Yield Parameters

Observations on polar diameter (cm), equatorial diameter (cm), fresh weight of fruit (g), dry weight of fruit (g) and fruit yield/ plot (kg) were recorded and presented as follows:

Polar diameter of fruit (cm)

Significantly highest polar diameter of fruit was measured under the T7 (50% N of RDF +4% nano urea + 200 PPM CCC at 30 and 60 DAT) 5.32 cm which was followed by 5.23 cm under T 10. Similar results were reported by Soumya *et al.,* (2009).

Equatorial diameter of fruit (cm)

Highest equatorial diameter of fruit was measured under the T7 (50% N of RDF +4% nano urea + 200 PPM CCC at 30 and 60 DAT) i.e. 5.07cm which was followed by T1 [(Control) (100% RDF)] i.e. 4.96.). Similar findings revealed by Mudasir et al., (2012), Siddaling et al., (2019), Meena *et al.,* (2017).

Fresh weight of fruit (g)

The results revealed significant effect of nano urea and PGR treatments. Significantly, Highest fresh weight of fruit was found under the T7 (50% N of RDF +4% nano urea + 200 PPM CCC at 30 and 60 DAT). valued 65.5 g which was followed by 62 g inT1 [(Control) (100% RDF)] both were found at par with each other. . These results are in close conformity with the findings of Mudasir *et al.,* (2009), Ilupeju*et al.,* (2015), Khan *et al.,* (2017), Singh *et al.,* (2017), Mohit *et al.,* (2019) and Siddaling*et al.,* (2017) in tomato

Dry weight of fruit (g)

The results revealed significant effect of nano urea and PGR treatments. Significantly, Highest dry weight of fruit was found under the T7 (50% N of RDF +4% nano urea + 200 PPM CCC at 30 and 60 DAT) valued 3.90 g which was followed by 3.50 g in treatment T1 [(Control) (100% RDF)]. Finding corroborates with their results estimated by Mudasir et al., (2014), Siddaling*et al.,* (2017), Meena et al., (2017).

Fruit yield (kg/plot)

The significantly the maximum yield was recorded treatment T7 (50% N of RDF +4% nano urea + 200 PPM CCC at 30 and 60 DAT). Valued 19.8 kg. and followed by T1 [(Control) (100% RDF)] valued 17.90 kg. The present results are in close conformity with the results of Mohit *et al.,* (2019).

Fruit yield (q/ha)

The significantly the maximum yield was recorded treatment T7 (50% N of RDF +4% nano urea + 200 PPM CCC at 30 and 60 DAT). Valued 270.00 q/ha. And followed by T1 (100% RDF) valued 246.00 q/ha. This result conformity with the findings has by Meena et al., (2017), Parmar *et al.,* (2019).

Quality parameters

Shelf life of fruit (at room temperature)

Shelf life of fruit was recorded with maximum in the treatment T7(50% N of RDF +4% nano urea + 200 PPM CCC at 30 and 60 DAT) valued 13.35 days and followed by T10 (75% N of RDF +4% nano urea + 200 PPM CCC at 30 and 60 DAT) valued 13.20 days. These findings are in agreement with findings reported by Kumar *et al.,* (2017).

Total soluble solids (°Brix)

The highest T.S.S. was observed in treatment T7 (50% N of RDF +4% nano urea + 200 PPM CCC at 30 and 60 DAT) valued 4.90 (0brix) followed by T10 (75% N of RDF +4% nano urea + 200 PPM CCC at 30 and 60 DAT) valued 4.50 (^{0}brix). The similar findings were also reported in tomato by Ilupeju*et al.,* (2015), Mohit *et al.,* (2019), Premshekhar and Rajshree, (2009) in tomato.

Acidity (%)

The highest Acidity was observed in treatment T7 (50% N of RDF +4% nano urea + 200 PPM CCC at 30 and 60 DAT) valued 0.75 (%) followed by T10 (75% N of RDF +4% nano urea + 200 PPM CCC at 30 and 60 DAT) valued 0.68 (%). The increase in titratable acidity might be due to the increased activity of the enzyme acetone. Kumar *et al.,* (2017).

CONCLUSION

All the treatment show significantly differences for most of the trait under study. The treatment T_7 (50% N of RDF as prilled urea +4% nano urea + 200 PPM CCC at 30 and 60 DAT), was found as the best treatment for majority of traits viz. Plant height (cm), Number of branches per plant, Number of leaves per plant, Leaf area (cm^2), Days to first flowering, Days to 50% flowering, No of flower cluster per plant, First picking of fruit, fresh weight of fruit(g), dry weight of fruit(g), polar diameter of fruit(cm), equatorial diameter of fruit

Table - 2 : Effect of different doses Nano urea and CCC growthtraits of Tomato.

Treatments	Plant height (cm)					Number of branches per plant					Number of leaves per plant					Leaf area per plant (cm^2)				
	20 DAT	40 DAT	60 DAT	80 DAT	120 DAT	20 DAT	40 DAT	60 DAT	80 DAT	120 DAT	20 DAT	40 DAT	60 DAT	80 DAT	120 DAT	20 DAT	40 DAT	60 DAT	80 DAT	120 DAT
T_1	38.22	47.04	71.62	95.20	113.38	1.64	3.42	6.04	13.68	21.92	6.35	15.10	49.00	67.75	76.76	165.99	199.97	199.97	326.15	335.30
T_2	31.22	38.72	64.80	87.92	104.38	1.55	3.01	5.95	12.06	21.60	5.22	13.65	40.55	60.55	70.32	105.35	136.90	180.12	223.8	287.45
T_3	31.32	36.72	60.80	86.92	104.38	1.59	2.97	5.23	11.98	21.03	5.19	14.55	42.60	61.98	71.20	107.56	124.12	198.22	236.70	298.19
T_4	31.30	38.62	60.89	88.25	102.45	1.46	3.07	5.65	11.87	21.22	5.55	14.32	42.56	62.44	72.40	109.56	122.9	187.01	259.16	294.12
T_5	32.86	40.18	62.25	88.43	106.44	1.40	2.99	5.16	12.09	20.95	5.95	13.98	46.88	66.25	68.20	123.80	176.5	198.56	276.12	301.65
T_6	33.00	40.97	65.35	90.43	107.20	1.36	3.11	5.78	13.00	20.92	5.99	14.88	45.21	63.20	70.44	145.87	164.99	201.01	289.76	310.80
T_7	35.72	46.03	70.26	93.11	110.47	1.72	3.53	6.32	14.80	24.69	6.55	16.66	50.78	70.17	76.84	170.27	207.79	288.00	335.27	359.26
T_8	32.22	35.18	63.64	88.42	102.86	1.55	2.98	5.98	13.03	22.65	5.88	14.87	45.87	66.23	72.35	155.66	175.87	210.90	289.77	310.10
T_9	32.11	40.68	66.32	90.64	107.58	1.47	2.96	5.87	12.22	22.95	6.00	15.00	48.13	66.88	73.66	146.98	168.22	206.45	315.55	331.80
T_{10}	32.00	38.30	61.00	91.34	100.45	1.23	3.19	5.45	11.23	21.40	5.46	14.26	44.22	59.22	72.11	149.45	157.88	199.64	264.99	318.12
T_{11}	32.10	38.72	64.83	88.92	103.48	1.15	2.97	5.22	10.10	18.98	5.77	14.59	45.30	61.11	73.54	151.00	165.3	201.98	299.71	312.77
SE(m)±	**0.1298**	**0.087**	**0.0179**	**0.035**	**0.4560**	**0.265**	**0.230**	**0.090**	**0.1719**	**0.1060**	**0.0036**	**0.0059**	**0.3114**	**0.1758**	**0.0442**	**0.265**	**0.230**	**0.090**	**0.1719**	**0.1060**
CD at 5%	**0.382**	**0.256**	**0.052**	**0.105**	**1.346**	**0.784**	**0.681**	**0.267**	**0.507**	**0.3129**	**0.0107**	**0.017**	**0.918**	**0.518**	**0.1306**	**0.784**	**0.681**	**0.267**	**0.507**	**0.312**

Table - 3 : Effect of different doses Nano urea and CCC onyield and quality trait of Tomato.

Treatments	Days After Transplanting		No of flower cluster per plant	First picking of fruit	fresh weight of fruit(g)	dry weight of fruit(g)	polar diameter of fruit(cm)	equatorial diameter of fruit (cm)	Number of fruits per plant	fruit yield (kg/plot)	fruit yield (q/ha)	Shelf life of fruit at room temperature	TSS (°Brix)	Acidity (%)
	IstFlower initiation	50% flowering												
T_1	42.39	53.25	27.72	83.00	62.00	3.50	5.21	4.96	44.00	17.9	246.00	13.00	4.34	0.55
T_2	45.00	55.19	22.10	86.12	51.90	2.59	4.26	4.29	40.12	13.00	222.00	12.12	3.50	0.58
T_3	46.01	55.65	21.30	87.60	50.50	2.70	4.44	4.39	41.75	14.5	232.40	12.80	3.80	0.57
T_4	44.97	55.98	20.4	85.44	55.40	2.60	4.34	4.38	42.91	15.1	235.40	11.20	3.97	0.59
T_5	43.98	56.77	22.98	85.73	54.30	2.90	4.37	4.41	43.45	14.7	227.30	12.55	3.92	0.60
T_6	44.70	55.99	25.14	85.99	55.20	3.00	4.40	4.36	42.12	15.0	230.50	12.30	3.99	0.65
T_7	42.22	54.39	28.40	84.00	64.50	3.90	5.32	5.07	47.00	19.8	270.00	13.25	4.90	0.75
T_8	46.13	56.05	22.01	87.10	57.40	3.01	4.33	4.22	43.50	15.08	232.90	11.70	4.17	0.61
T_9	46.87	56.70	22.21	86.50	56.60	3.17	4.64	4.56	42.89	15.2	234.50	12.60	4.20	0.63
T_{10}	43.22	54.98	26.50	85.11	58.00	3.19	5.00	4.54	43.10	16.0	237.20	13.20	4.50	0.68
T^{11}	42.50	55.99	23.44	86.23	56.00	2.99	4.26	4.37	41.99	14.5	229.60	11.90	3.90	0.57
SE(m)±	**0.481**	**0.6533**	**0.102**	**0.322**	**0.3334**	**0.1001**	**0.1922**	**0.0382**	**0.943**	**2.27**	**20.02**	**0.1952**	**0.0647**	**0.008**
CD at 5%	**1.42**	**1.9273**	**0.302**	**0.9501**	**1.3419**	**0.2971**	**0.3672**	**0.1127**	**2.75**	**5.76**	**58.54**	**0.576**	**0.1909**	**0.0238**

(cm), Number of fruits per plant, fruit yield (kg/plot), fruit yield (q/ha), Shelf life of fruit at room temperature, TSS (°Brix), Acidity (%).

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INTEGRATED NUTRIENT MANAGEMENT FOR OPTIMIZING MICRONUTRIENT SUPPLY IN OKRA PRODUCTION : CHALLENGES AND OPPORTUNITIES

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ABSTRACT

Okra *(Abelmoschus esculentus)* is an important vegetable crop grown worldwide. Optimizing micronutrient supply is crucial for achieving optimal growth, development, and yield in okra production. This review paper discovers the challenges and opportunities of integrated nutrient management (INM) for optimizing micronutrient supply in okra production. The nutrient requirements of okra, the role of micronutrients in growth and development, and the symptoms of nutrient deficiencies are discussed. The adoption of INM practices faces barriers such as limited awareness and knowledge, limited access to resources, cost considerations, and traditional beliefs and practices. However, the amended nutrient management in okra production offers socio-economic implications such as increased crop productivity and yield, enhanced nutritional value, sustainable farming systems, and rural employment opportunities. Technological advancements, including precision agriculture, offer future prospects for optimizing nutrient management in okra production. The implications for okra growers and policymakers are highlighted, along with recommendations for future research and application. General, this review emphasizes the importance of integrated nutrient management in optimizing micronutrient supply for sustainable okra production.

Keywords : *Okra: integrated nutrient management: micronutrient supply: nutrient deficiencies: soil fertility; sustainable agriculture.*

INTRODUCTION

A. Background and Significance of the Study

Okra (Abelmoschusesculentus) is an important vegetable crop cultivated worldwide due to its nutritional value and culinary versatility [1]. It is rich in numerous essential nutrients such as carbohydrates, proteins, vitamins, and minerals, which contribute to a healthy diet 121. Among the minerals. micronutrients play a crucial role in the growth, growth, and overall productivity of okra plants [3].

Micronutrients, including "iron (Fe), zinc (Zn), manganese (Mn), copper (Cu), boron (B), molybdenum (Mo), and nickel (Ni), are obligatory in small quantities but are essential for various biochemical and physiological processes in plants" [4]. These micronutrients are involved in enzyme activation, photosynthesis, hormone synthesis, and overall plant metabolism [5]. Lacking availability of micronutrients can lead to nutrient deficiencies in okra plants, resulting in reduced yield, poor quality, and increased susceptibility to diseases and pests [6].

In conventional farming practices, the primary focus has been on the application of macronutrients, such as nitrogen (N), phosphorus (P), and potassium (K), while the importance of micronutrients has often been overlooked [7]. This neglect of micronutrient management can have detrimental effects on crop production, especially in areas where soils are inherently deficient in these elements or have limited nutrient availability [8].

Moreover, the indiscriminate use of chemical fertilizers without considering the specific nutritional requirements of okra plants can lead to imbalances in nutrient uptake, affecting both plant health and the environment [9]. Extreme fertilizer application can cause nutrient leaching, pollution of water bodies, and other ecological issues [10].

To address these challenges and optimize micronutrient supply in okra production, the Concept of integrated nutrient management (INM) has gained attention [11]. INM involves The judicious combination of organic amendments, bio fertilizers, micronutrient-enriched fertilizers, foliar sprays, and other innovative practices to enhance nutrient availability. minimize nutrient losses, and ensure balanced nutrition for crops [12].

By examining the current research and obtainable literature, this review aims to provide a Comprehensive understanding of the importance of micronutrients, the limitations of Conventional practices, and the potential of INM methods in promoting sustainable and efficient okra cultivation.

II. OKRA PRODUCTION AND NUTRIENT REQUIREMENTS

A. Overview of Okra Production and Its Importance

Okra (Abelmoschusesculentus) is a warm-season vegetable crop It is widely cultivated in tropical and subtropical regions due to its flexibility to high temperatures and tolerance to drought conditions [1]. Okra holds great agricultural and economic significance in many countries, as it serves as a source of income for farmers and contributes to food security. benefits [2]. Its popularity can be credited to the presence of bioactive compounds, dietary fiber, antioxidants, and vitamins in its pods [3].

B. Nutrient Requirements of Okra

Macronutrients, clouding nitrogen (N), phosphorus (P), and potassium (K), play a energetic role in okra growth. Nitrogen is needed for vegetative growth, leaf development, and overall plant vigor, Phosphorus promotes root development, flowering, and fruit formation. Potassium contributes to disease resistance, water regulation, and fruit quality [4].

In addition to macronutrients, okra also require micronutrients for various physiological and biochemical processes. Micronutrients, such as "iron (Fe), zinc (Zn), manganese (Mn), copper (Cu), boron (B), molybdenum (Mo), and nickel (Ni), are essential for enzyme activation. Photosynthesis, hormone synthesis, and other metabolic functions"[5].

Iron (Fe) is essential for chlorophyll synthesis, energy transfer, and enzyme activities. Iron deficiency can result in intervene chlorosis, reduced leaf expansion, and poor fruit set in okra plants [6].

Zinc (Zn) is involved in enzyme activation, protein synthesis, and maxin regulation. It plays a significant role in root development, flower formation, and fruit maturation. Zn deficiency in okra can cause stunted growth, small leaves, and abnormal fruit development [7]

Manganese (Mn) is crucial for photosynthesis, nitrogen metabolism, and antioxidant enzymesystems. Mn deficiency can lead to chlorotic leaves with necrotic spots and poor fruit development in okra plants [8].

Copper (Cu) is essential for several enzymatic reactions and plays a role in photosynthesis. lignin synthesis, and reproductive development. Cu deficiency in okra can result in twistedand dark-colored leaves, reduced flower formation, and fruit abnormalities [9].

Boron (B) is necessary for cell wall synthesis, pollen germination, and fruit development. B deficiency symptoms in okra include distorted leaves, poor flower formation, and reducedfruit set [10].

Molybdenum (Mo) is involved in nitrogen fixation, enzyme activation, and sulfur metabolism. Mo deficiency can lead to yellowing and mottling of older leaves in okra plants [11].

Nickel (Ni) is required for urease activity, nitrogen metabolism, and iron absorption. Nideficiency can cause chlorotic leaves, reduced growth, and poor fruit quality in okra [12].

Ensuring an adequate supply of micronutrients is crucial for maximizing okra yield,improving fruit quality, and enhancing plant resilience to biotic and abiotic stresses.

III. CHALLENGES IN MICRONUTRIENT MANAGEMENT IN OKRA PRODUCTION

A. Nutrient Deficiencies Their Symptoms in Okra

Micronutrient deficiencies can suggestively affect the growth and development of okra . leading to reduced yields and poor fruit quality. Understanding the indications associated with these deficiencies is crucial for effective management.

Iron (Fe) Deficiency: Iron deficiency in okra, often referred to as iron chlorosis, ischaracterized by interveinal chlorosis, with yellowing occurring between the leaf veins while the veins themselves remain green. Severe iron deficiency can lead to leaf necrosis and reduced plant vigor [1].

Zinc (Zn) Deficiency: Zn deficiency symptoms in okra include stunted growth, shortened internodes, small leaves with interveinal chlorosis, and reduced fruit development. The leaves may also exhibit distinct veinal chlorosis [2].

Manganese (Mn) Deficiency: Mn deficiency in okra is manifested by interveinal chlorosisin young leaves, often progressing to necrotic spots. The leaves may become mottled, and the plants may exhibit reduced growth and delayed flowering [3].

Copper (Cu) Deficiency: Cu deficiency symptoms in okra include wilting and twisting ofyoung leaves, darkening of leaf margins, and overall poor growth. Flowering may be limited. leading to reduced fruit set [4].

Boron (B) Deficiency: B deficiency can cause distorted and brittle leaves in okra, with marginal chlorosis and necrosis. The plants may exhibit reduced flower formation and fruit set, resulting in a low yield [5].

Molybdenum (Mo) Deficiency: Mo deficiency symptoms in okra include yellowing and mottling of older leaves, similar to nitrogen deficiency. The plants may exhibit reduced growth, delayed maturity, and abnormal flower development [6]

B. Factors Influencing Micronutrient Availability in Soils

Several factors influence the availability of micronutrients in soil, affecting their uptake by okra plants. These factors include:

Soil pH: Soil pH plays a crucial role in micronutrient availability. Some micronutrients, such as iron and manganese, are more available to plants under acidic conditions, while others, such as zinc and molybdenum, are more available under neutral to slightly alkaline pHlevels [7].

Soil Organic Matter: enhances micronutrient availability by improving soil structure, cat ion exchange capacity, and nutrient retention, Organic matter also promotes microbial activity, which aids in the release and transformation of micronutrients [8].

Soil Texture: Clay soilstend to retain micronutrients more tightly, making them less available to plants. Sandy soils,on the other hand, have lower nutrient-holding capacity and may require more frequent micronutrient applications [9].

Soil Moisture and Drainage: Adequate soil moisture is essential for optimal micronutrient uptake by plants. Excessive moisture or poor drainage can lead to waterlogging and oxygen deprivation, affecting root function and nutrient uptake [10].

Interactions with Other Elements: Micronutrient obtainability can be influenced by interactions with other elements in the soil. For example, high phosphorus points can inhibit the uptake of iron and zinc by plants. Similarly, excessive application of certain micronutrients, such as copper, can interfere with the uptake of other micronutrients [11].

C. Limitations of Conventional Fertilizer Practices

Conventional fertilizer practices often focus primarily on the application of macronutrients, neglecting the importance of micronutrients. This approach can lead to micronutrient deficiencies and imbalances in the soil-plant system.Lack of Micronutrient-Specific Fertilizers: Conventional fertilizers typically contain higher levels of macronutrients and may not provide sufficient micronutrients. [12].

Uniform Fertilizer Application: Conventional practices often involve uniform fertilizer application without considering the spatial and temporal variations in soil nutrient levels.[13].

Limited Nutrient Use Efficiency: Conventional fertilizer practices may have limited nutrient use efficiency, as some applied nutrients can be lost through leaching, runoff, or volatilization. [14].

Negative Environmental Impacts: Excessive fertilizer use, including conventional practices, can have adverse environmental impacts. [15].

To address these limitations, alternative approaches such as integrated nutrient management (INM) are being explored to optimize micronutrient supply in okra production and promote sustainable agricultural practices.

IV. INTEGRATED NUTRIENT MANAGEMENT (INM) APPROACHES

A. Overview of Integrated Nutrient Management

INM is an approach emphasizes the sensible andbalanced use of organic and inorganic nutrient sources to optimize nutrient availability. Improve soil fertility, and enhance crop productivity. INM aims to achieve sustainable and environmentally friendly agricultural practices by combining numerous nutrient management strategies [1].

B. Importance of Balanced Nutrition in Okra Production

Balanced nutrition is crucial for achieving optimal growth, development, and yield in okra production. A balanced nutrient supply enhances the plant's ability to carry out essential physiological processes, such as photosynthesis, nutrient uptake, and metabolism. This, inturn,promotes better root development, improved flowering, fruit set, and overall crop performance [2].

C. Use of Organic Amendments for Micronutrient Supply

Organic amendments, such as farmyard manure, compost, and crop residues, play a vital in integrated nutrient management for okra production. Organic amendments enhance soil fertility, recover soil structure, and increase water holding carity. They also promote the activity of helpful soil microorganisms, which aid in nutrient cycling and make micronutrients more available to okra plants [3].

D. Utilization of Biofertilizers and Microbial Inoculants

Biofertilizers and microbial inoculants are valuable components of integrated nutrient management in okra production. These products contain beneficial microorganisms that interact with the plant's root system, promoting nutrient uptake and enhancing plant growth.

Rhizobium and Bradyrhizobium strains, for example, are commonly used as biofertilizers to facilitate nitrogen fixation in leguminous crops, including okra [5].

The use of biofertilizers and microbial inoculants as part of INM practices offers several advantages, including reduced dependence on chemical fertilizers, enhanced nutrient use efficiency, and improved soil biological activity and resilience [7].

V. BEST PRACTICES FOR OPTIMIZING MICRONUTRIENT SUPPLY IN OKRA PRODUCTION

A. Nutrient Management Strategies for Different Soil Types

Different soil types require specific nutrient management strategies to optimize micronutrientsupply. On the other hand, clay soils with higher nutrient retention capacity may require the incorporation of organic amendments, such as compost or well-rotted manure, to enhance micronutrient availability through improved soil structure and microbial activity [2]. Adjusting soil pH through liming can be beneficial for addressing micronutrient deficiencies in acidic soils [3].

B. Timing and Methods of Nutrient Application

Incorporating organic amendments, such as compost or well-rotted manure, before planting can enrich the soil with micronutrients [5]. Basal application of a balanced fertilizer containing macronutrients and micronutrients during planting or as a basal dressing ensures an initial nutrient supply for early growth and development [6].

C. Importance of Soil Testing and Plant Tissue Analysis

Consistent soil testing and plant tissue analysis are essential for determining the specific nutrient requirements of okra. Soil testing provides information about the nutrient station and pH of the soil, enabling growers to make informed decisions regarding fertilization plans and micronutrient supplementation [7]. Plant tissue analysis helps assess the nutrient levels in the crop during different growth stages, allowing for adjustments in fertilizer application and micronutrient management as needed [8].

D. Considerations for Sustainable and Environmentally Friendly Practices

When optimizing micronutrient supply in okra production, it is important to adopt sustainable and environmentally friendly practices. These include:

Balanced Nutrient Management: Ensuring a balanced supply of macronutrients and micronutrients to meet the specific nutritional requirements of okra plants promotes efficient nutrient use and minimizes the risk of nutrient imbalances. Integrated Nutrient Management: Integrating organic amendments, such as compost or well-rotted manure, biofertilizers, and microbial inoculants, can enhance nutrient availability, improve soil health, and reduce dependence on synthetic fertilizers. Nutrient Use Efficiency Implementing best management practices, such as split applications, foliar sprays, and the use of slow-release fertilizers, improves nutrient use efficiency and minimizes nutrient losses to the environment. Environmental Protection: Adhering to proper application rates, avoiding nutrient runoff, and preventing contamination of water bodies through responsible nutrient management practices contribute to environmental protection.

VI. ADOPTION CHALLENGES AND FUTURE OPPORTUNITIES

A. Barriers to the Adoption of Integrated Nutrient Management

These barriers include: Lack of Awareness and Knowledge: Farmers may have limited knowledge about the benefits of INM practices and the importance of micronutrient management. Awareness-raising programs, training sessions, and extension services can help address this barrier [1].

Limited Access to Resources: Some farmers may face challenges in accessing thenecessary resources for implementing INM practices, such as organic amendments. Biofertilizers and microbial inoculants. Improving access to these resources through B subsidies, credit schemes, or cooperative farming initiatives can help overcome this barrier.

Cost Considerations: The cost of implementing INM practices, including the procurement of organic amendments and microbial products, can be a deterrent for some farmers. Providing financial incentives, promoting cost-effective practices, and demonstrating the long-term benefits of INM can help overcome this barrier [3].

- Traditional Beliefs and Practices: Farmers may be resistant to change due to traditional beliefs or established farming practices [4].

B. Socio-economic Implications of Improved Nutrient Management Improved nutrient management practices in okra production can have positive socio- economic implications for farmers and communities. These include:

Increased Crop Productivity and Yield: Proper nutrient management, including the optimization of micronutrient supply, can improve crop productivity and yield. This,

in turn, enhances farmers' income and food security [5]. Enhanced Nutritional Value: Optimal nutrient management contributes to the nutritional quality of okra, providing consumers with nutrient-rich and healthier food options [6]. Sustainable Farming Systems: INM practices promote sustainable farming systems by reducing the reliance on synthetic fertilizers, minimizing nutrient losses to the environment, and improving soil health. This leads to long-term agricultural sustainability and resource conservation [7].Rural Employment Opportunities: The adoption of INM practices may create additional employment opportunities in the production, processing, and marketing of organic amendments and microbial products. This can contribute to rural developmentand livelihood improvement [8].

C. Technological Advancements and Future Prospects

Technological advancements offer promising prospects for optimizing nutrient management in okra production. These include: Precision Agriculture: Precision agriculture technologies, such as remote sensing. GPS mapping, and sensor-based nutrient monitoring, can enable farmers to make precise nutrient management decisions based on real-time data. This improvesnutrient use efficiency and reduces wastage [9].

VIL CONCLUSION

A. Summary of Key Findings

This review paper has highlighted the importance of integrated nutrient management (INM) for optimizing micronutrient supply in okra production. Key findings include:

Okra plants have specific nutrient requirements, including micronutrients, for optimal growth and development. Micronutrient deficiencies can lead to reduced yields, poor fruit quality, and various . symptoms in okra plants. Factors such as soil type, pH, and organic matter content, and moisture levels.influence the availability of micronutrients in the soil.Conventional fertilizer practices may not adequately address micronutrient. deficiencies and can have limitations in nutrient use efficiency. Organic amendments, biofertilizers, and microbial inoculants offer effective strategies for enhancing micronutrient supply and improving soil fertility.Adoption of INM practices can contribute to sustainable okra production, increased crop productivity, enhanced nutritional value, and socioeconomic benefits.

B. Implications for Okra Growers and Policymakers

The findings of this review have several implications for okra growers and policymakers. Okra growers can benefit from adopting INM practices tailored to their specific soil conditions and nutrient requirements. Implementing proper nutrient management strategies,including timely and targeted nutrient applications, can optimize micronutrient supply. improve crop productivity, and enhance farm profitability. Policymakers play a crucial role in promoting sustainable okra production by creating anenabling environment. They can Provide training programs and extension services to increase awareness and knowledge about INM practices among farmers.Encourage research and development initiatives to enhance the availability andaffordability of micronutrient-enriched fertilizers and other INM inputs.

C. Directions for Future Research and Application

There are several areas for future research and application in the field of integrated nutrient management for okra yield.

Assessment of the long-period effects of INM practices soil health, nutrient cycling and overall ecosystem sustainability.Evaluation of the economic viability and cost-effectiveness of different INMstrategies for okra growers.

By addressing these research gaps and applying the findings to practical on-farm applications, the optimization of micronutrient supply in okra production can be furtheradvanced, leading to improved yields, enhanced food security, and sustainable agriculturalpractices.

In conclusion, integrated nutrient management offers promising opportunities for optimizing micronutrient supply in okra production. By adopting INM practices, okra growers can improve crop productivity, nutritional value, and sustainability while policymakers can support and promote these practices through appropriate policies and resource allocation. Continued research and application of INM strategies will contribute to the advancement of okra production and sustainable agriculture as a whole.

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MARKETING OF RED CHILLI IN AZAMGARH DISTRICT OF UTTAR PRADESH, INDIA

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ABSTRACT

Chilli (*Capsicum annum L.*) is one of the most important commercial crop in India. It is grown throughout the country. The largest chilli producing is country China in the word and Andhra Pradesh is the largest producing state in India. The present study has focused on To find out the different marketing channels of red chillimarketing margin, price spread and constraints faced by grower in marketing. A list of villages under Tehbarpur Block were prepared on the basis of area under red chilli crop, 5 villages were selected as per purposely random sampling, from the list.On an average per farm, total production, marketable surplus and marketed surplus of red chilli were 90.45,90.01 & 90.01 quintal, respectively. Total disposal quantity of red chilli was 271 quintal which was disposed of through three channels. Disposal quantity under Channel-Ⅰ, Channel-Ⅱ, & Channel-Ⅲ were 5.20,22.82 & 242.99 quintals, respectively. The average net price received by producer under Channel-Ⅰ, Channel-Ⅱ & Channel-Ⅲ for red chilli were Rs.4418.32, 4427.34 & 4477.92 respectively. Average marketing costs, margin and price spread in number of middle man from Channel-Ⅱ&Channel -Ⅲ. By comparing price spread margins found maximum were 1442.34, 743.12 &133.62 under Channel-Ⅲ, Channel-Ⅱ & Channel-Ⅰ, respectively. Due to existence of wholesaler in Channel-Ⅲ, the net margins were workout to be 8.80%, respectively.

Keywords: *Chilli, marketing efficiency, marketing cost, price spread, marketable surplus, marketing constraints.*

INTRODUCTION

Vegetables are one of the important aspects of the horticulture sector in India. Most of the population of India lives in villages and the main occupation of the villages are agriculture. India is second largest producer of vegetables in the world next to China. During 2022-2023, the area under vegetables is estimated at 12 million hectare with a production of 209.14 million tons in India. In 2022-2023 the vegetable production was highest in case of Uttar Pradesh (29.58 million tons) followed by West Bengal (29.50 million tons). Per capita availability of vegetables in the country is 400.1 (in grams / person / day). Chilli (Capsicum annum L.) is one of the most important commercial crops in India. Chilli is used in number of activities such as vegetables, spice, condiments, sauce, pickles. It is indispensable item in the kitchen as it is consumed daily as condiments in one or the other form. Dryred chilli in a spice that add pungency and add to colour to dishes. It has antimicrobialand analgesic properties in addition to serving as a pain reliever. In India the area under chilli crop was sown in 2021-2022 was 851thousands hectare with total production of

1874thousands tons. The production of red chilli in Uttar Pradesh was about 27.49 tons in 2022-2023. In area, production and productivity of red chilli in Azamgarh district was 1200 hac. 8400 tons and 70.86 qt./hac respectively.

Review Cited:

To carry out the present study different review related to problem are cited and presented here:

Balroj et al.*(2018*) Studied on "Problems of Green chilli Cultivation and Marketing in Ramanathapuram District", attempted to identify the problems faced by farmers during the green chilli cultivation and marketing in Thirupullani block of Ramanathapuram District, Tamilnadu. The study found that the area under green chilli cultivation in Ramanathapuram district was showing a decreasing trend over the years. Emphasis should be given for providing good quality seeds, pest and diseases resistant with high yielding varieties and hybrids to augment the area under this spice crop, in order to take advantage of commercial trade. The lack of technical knowledge was a major problem which occupied and topped the rank with 90 per cent This paper concluded that the green chilli growers needed to be educated regarding the use of treated seeds, maintaining correct pacing and irrigating the crop at the recommended intervals. The farmers needed to be minimum supporting pricing and subsides, so that they could get the high returns by reducing the expenditure.

*Jorwar et al. (2019)*studied on "Economics of Production and Marketing of Green chilli in Amravati District". To study the existing marketing channels of green chilli there were three channels found namely Channel-I Producer – Consumer, Channel-II Producer - Retailer - Consumer and Channel-III Producer - Wholesaler - Retailer - Consumer. The study found that in case of green chilli the price spread through channel-I was Rs. 214.80 per quintal. In case of channelIII the price spread of green chilli was Rs. 923.26 per quintal. The marketing efficiency of green chilli in channel-I was 24.02. In case of channel-III marketing efficiency of green chilli was 8.24.

*Rais et al. (2021)*conducted to determine the constraint in production and marketing faced by green chilli farmers and markets intermediaries in Sindh, Pakistan. Three districts were selected of the Sindh province i.e. Umerkot, Khairpur and Sanghar for this research. Data were collected through personal interview from four villages and 120 selected respondents from each district with the help of well-structured questionnaire. The collected information from the green chilli growers revealed that major constraints were insect pests and disease problem (82%), lack of modern irrigation system (76%), imbalance use of fertilizer and pesticide (75%), lack of training (70%) respectively. In marketing side major constraints were commission agent charges are not reasonable (76%), price fluctuations (56%) and lack of proper storage facilities (47%) recorded in Sindh. Furthermore lack of grading facility (90%) was the major constraints faced by the green chilli traders in study areas. Lack of storage facility (77%) was recorded as a second highest constraints faced by the traders followed by high risk is involved in selling of green chillies distant places (73%) in Sindh. Based on the findings it is suggested that proper trainings and extension services may be start with special reference to proper production technology. Green chilli farmers are also suffering due to improper weight and measure by traders and commission agent, it is therefore suggested commercial bank, regulated markets and co-operative marketing society should adopt flexible lending policy to suit the need of the farmers on the security of green chilli crop.

MATERIALS AND METHODS

1. Selection of producers

Information from the producer who sold their produce to the direct consumer in the daily and weekly market under the scheme of producer to consumer there was selected for this study.

2. Selection of wholesalers

In Azamgarh, Nizamabad was vegetable market, 5 wholesaler in the market for the chilli was selected.

3. Selection of retailers

In Azamgarh vegetable market, Semari vegetable market & Tahbarpur vegetable market 5 retailers for the chilli was selected purposively.

4. Data collection

Survey method was used for collecting primary data on production and marketing of chilli vegetable. Questionnaire containing detail information about cultivators, cultivation of crops, grass return, wholesale price, retail price, market functionaries, expenditure and profit etc. were prepared for collection of data.The scheduled was pretested and thereafter finalised for collecting the information. Data pertains to the year 2023.

5. Marketing cost and market margin

Marketing cost are the actual expenses incurred by producer, wholesaler and retailer. Market margin is thus included total cost of marketing and the profit or less due to intermediaries i.e. commission agent and retailer in the process of movement of producer from farmers to the final consumer.

6. Market margin

$$AM = Pma - (Pba + Mc)$$

Where,

Am = Absolute margin of the middlemen in the trade

Pm = Selling price of the trader

Pb = Buying price of the trader Mc = Marketing costs of trader

7. Price spread

In marketing of agricultural commodities the difference between price paid by the consumer and price received by the producer for an equivalent quantity of farm produce often known as price spread.

8. Marketing Efficiency

The marketing efficiency of the selected channels was studied with the help of slightly shepherd's formula as given below.

$$M.E. = \frac{V}{I} - 1$$

Where,

ME = Index of marketing efficiency

V = Value of Chilli

1= Total marketing cost

Disposable pattern of chilli:

A comprehensive study of the chilli marketing system becomes imperative to comprehend its complexities and identity bottlenecks, ultimately leading to the provision of efficient services in transferring farm produce and inputs from producer to consumer. An effective marketing system not only minimize costs, but also benefits of all sections of society. Marketing serves as the ultimate stage in any production system and its efficiency is crucial for ensuring that produce reaches consumers in pristine condition, devoid of damage, at the lowest possible cost and in the shortest time after harvest. According to Kohls, marketing encompasses all goods and services, starting from initial agricultural production until they reach the hands of the ultimate consumer. The core objective of an efficient marketing system includes enable primary producers to maximize their benefits, offering farm origin products to consumers at reasonable prices without compromising the shortest time after harvest. According to Kohls, marketing encompasses all goods and services, starting from initial agricultural production until they reach the hands of the ultimate consumer.

The core objective of an efficient marketing system includes enable primary producers to maximize their benefits, offering farm origin products to consumers at reasonable prices without compromising quality, facilitating the upliftment of all produce the farmers are willing to sell at incentive prices, and reducing the price spread between primary produce and the ultimate consumer.

Marketing channel

The study focuses on three key marketing channels for chilli growers in the region:

Channel- Ⅰ : Producer ➔Consumer

Channel- Ⅱ : Producer ➔Retailer➔Consumer

Channel- Ⅲ: Producer ➔ Wholesaler ➔ Retailer ➔ Consumer

Price spread and marketing efficiency:

Table 1 outlines the price spread and marketing efficiency of dry red chilli. According this table price spread channel- Ⅰ Rs.133.62, channel- Ⅱ, Rs. 743.12 and channel- Ⅲ Rs.1142.34 and marketing efficiency 32.18, 5.96 & 3.82, channel- Ⅰ channel- Ⅱ and channel- Ⅲ respectively.

Table - 1 : Price spread and marketing efficiency of red chilli

S. No.	Channel	Price spread	Marketing efficiency
1.	I	133.62	32.18
2.	II	743.12	5.96
3.	III	1142.34	3.82

Marketable Surplus

Table 2 highlights the estimated marketable surplus of red chilli. While red chilli is highly perishable, making immediate sale necessary, it possesses better storage capacity than other commodities. Although lack of infrastructure may force farmers to sell immediately after harvest, they can benefit from storing chillies at the household level. Storing allows them to wait for better market prices, maximizing their returns. The flexibility in selling offers an opportunity for farmers to optimize their income and make strategic marketing decisions to their advantage.

Table - 2 : Marketable surplus of red chilli of sampled households

(Quintal per farm)

S. No.	Particulars	Group			Overall average
		Marginal	Small	Medium	
A.	**Total production (qt.)**	91.00 (100.00%)	90.00 (100.00%)	90 (100.00%)	90.45 (100.00%)
1.	**Family consumption (qt.)**	0.42 (0.46%)	0.46 (0.50%)	0.46 (0.50%)	0.44 (0.49%)
2.	**Marketable surplus (qt.)**	90.58 (99.54%)	89.54 (99.50%)	89.54 (99.50%)	90.01 (99.51%)
3.	**Marketed surplus (qt.)**	90.58 (99.54%)	89.54 (99.50%)	89.54 (99.50%)	90.01 (99.51%)

Note: Figure in parentheses indicates percentage to total quantity produced.

The total production of red chilli was 90.45 quintal while it's uses for family consumption recorded 0.44 quintal. The marketable surplus was recorded 90.01 quintal and it was equal in case of small and medium farmer's i.e. 89.54 quintal while it was higher for marginal farms i.e. 90.58 quintal respectively.

Constraints in the marketing of red chilli:

The farmers were asked to list priority wise five major constraints they were facing in marketing of red chilli. All these were shorted screened and given them a marketing of rank according to the Garrett method. Lack of storage facilities was the biggest issue in red chilli marketing with the mean score 54.70. Not satisfied with market facilities and charges were also major issue in the study area followed by lack of transportation facilities, more price fluctuation and less knowledge of price information with the mean score 52.09, 51.79, 46.12 and 42.39 respectively.

Table - 3 : Constraints in the marketing of red chilli

Problems	Percent position	Garrett value	Mean score	rank
Lack of storage facilities	10	75	54.70	1
Not satisfied with market facilities and charges	30	60	52.09	2
Lack of transportation facilities	50	50	51.79	3
More price fluctuation on selling time	70	40	46.12	4
Less knowledge of price information	90	20	42.39	5

CONCLUSION

The marketing of red chilli analysis highlights the marketing channels, price spread and marketing efficiency. Optimizing operation costs, exploring cost effective seed procurement methods and adopting efficient farming practices can enhance profitability. Marketing is crucial, addressing market access, price volatility, information challenges can improve farmers income and reduce vulnerability. Strategies like collective marketing, value addition and direct market links are recommended for better market participation and price realization. Price spread channel- Ⅰ Rs.133, channel-Ⅱ, Rs.743.12 and channel-Ⅲ Rs.1142.34 and marketing efficiency 32.18, 5.96 & 3.82, channel-Ⅰ channel-Ⅱ and channel-Ⅲ respectively. The overall production of red chilli 90.45 qt/hec. Reduce the different marketing constraints, whereby farmer increase the income, which will improve their financial conditions.

Suggestions

1. Government department like department of agriculture, plant protection and irrigation should assure the timely and adequate supply of the inputs and irrigation water.
2. Government should also ensure the quality inputs are supplied to the farmer by different agencies.
3. Agencies involved in disseminating the improved scientific techniques should organized more skill oriented practical training programs in order top increase the knowledge and skill of red chilli growers.
4. To update one self about agricultural knowledge and knew technology farmers should call "Kisan Call Centre"**No. 18001801551 and** "IFFCO Kisan Call Centre"also provide the facilities for the farmer regarding agriculture on his number 534351.
5. Through the Kisan Credit Cards and other financial schemes of institutional credit have proved helpful for the farmers. But to make it more efficient these facilities should be easier and more liberal. Adoption of co-operative farming and the formation of SHG/FPO may help to solve the many problems of the producers related to production and marketing.
6. Time to time farmers interaction with the bank personnel should be organized to solve the credit/finance related problems.

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AN ECONOMIC ANALYSIS OF RED CHILLI IN AZAMGARH DISTRICT OF UTTAR PRADESH, INDIA

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ABSTRACT

Chilli (*Capsicum annum L.*) is one of the most important commercial crop in India. It is grown throughout the country. The largest chilli producing counrty is China in the word and Andhra Pradesh is the largest producing state in India. The present study has focused on "To estimate the cost and return per hectare of chilli for this", a list of villages under Tehbarpur Block were prepared on the basis of area under red chilli crop, 5 villages were selected as per purposively multistage sampling, from the list. Total 100 respondents were selected from 5 villages under study to achieve the objective &simple tabular analysis and cost concept has used to find out the result. It was found that the red chilli cultivation is profitable at all categories of farm. The total cost of cultivation and gross income per hectare was positively related to the size of farms. The overall average cost of cultivation and average net returns was found Rs. 154992.02 per hectare and Rs. 257789.84 per hectare respectively.

Keywords : *Cost of cultivation, net income, cost concepts, red chilli production.*

INTRODUCTION

Vegetables are one of the important aspects of the horticulture sector in India in particular and of the agricultural sector of the India in general. Most of the population of the India lives in villages and the main occupation of the villages are agriculture. India continues the second largest producer of vegetables in the world next to China. During 2022-2023, the area under vegetables is estimated at 12 million hectare with a production of 209.14 million tons in India. Per capita availability of vegetables in the country is 400.1 (in grams / person / day). Chilli (Capsicum annum L.) is one of the most important commercial crops in India. Chilli is used in number of activities such as vegetables, spice, condiments, sauce, pickles. It is indispensable item in the kitchen as it is consumed daily as condiments in one or the other form. Dryred chilli in a spice that add pungency and add to colour to dishes. It has antimicrobialand analgesic properties in addition to serving as a pain reliever. In India the area under chilli crop was sown in 2021-2022 was 851thousands hectare with total production of 1874thousands tons. The production of red chilli in Uttar Pradesh was about 27.49 tons in 2022-2023. In area, production and productivity of red chilli in Azamgarh district was 1200 hac. 8400 tons and 70.86 qt./hac respectively.

Review Cited:

To carry out the present study different review related to problem are cited and presented here:

Geeta et al. (2017) Studied on "Green chilli Production and Export from India" considered green chilli as one of the commercial spice crops in the world. It was the most widely used as universal spice, named as wonder spice.

The researchers examined to understand the area, production and productivity of green chillies in India and export marketing of green chillies. The study was based on the secondary data. The largest producer of green chillies in the world is India accounting for 13.76 million tonnes of production annually. In India, Green chilli was grown in an area 774.9 thousand hectare and production 1492.10 thousand tonnes and the productivity was 1.93 tonnes per hectare in 2014-15.

Balroj et al.*(2018*) Studied on "Problems of Green chilli Cultivation and Marketing in Ramanathapuram District" attempted to identify the problems faced by farmers during the green chilli cultivation and marketing in Thirupullani block of Ramanathapuram District, Tamilnadu. The study found that the area under green chilli cultivation in Ramanathapuram district was showing a decreasing trend over the years. Emphasis should be given for providing good quality seeds, pest and diseases resistant with high yielding varieties and hybrids to augment the area under this spice crop, in order to take advantage of commercial trade.

*Jorwar et al , (2019)*studied on"Economics of Production and Marketing of Green chilli in Amravati District", attempted made to study the cost and return structures of production of green chilli with a view to work out the economics of green chilli production. The economic analysis of data indicated that cost 'C' was found to be Rs.168507.96, Rs.181705.77and Rs 184739.08 per hectare for small, medium and large growers respectively. Net returns over cost 'C' was Rs.80619.40, Rs.93008.90 and Rs.107722.00 per 59 hectare and input-output ratio at cost 'C' was 1.48, 1.51 and 1.58 for small, medium and large growers respectively

MATERIALS AND METHODS

1. Sampling technique

The purposively multistage random sampling technique used for the selection of district, block, villages and respondents.

1.1 Selection of the study area

Azamgarh district of Uttar Pradesh was selected purposively, where chilli is cultivated. Chilli is cultivated on the land situated on the banks of Tamsa river in Azamgarh, Where soil suitable for chilli cultivation is found.

1.2 Selection of the block

There are 22 blocks in Azamgarh district out of, which Tahbarpur block have selected on the basis of maximum area under chilli crop.

1.3 Selection of the village

From the selected block a list of chilli grown villages were prepared and 5 villages (Muslimpatti, Semri, Antapur, Banhara and Ibrahimpur) were selected on the basis of maximum area under chilli crop.

1.4 Selection of respondents

After selection of villages, a list of chilli growing farmers was prepared and further categorized into three size group on the basis of size of land holding, viz. Marginal (up to 1.0hac.), Small (1.0-2.0hac.), Medium (2.0hac. and above).

2. Nature and source of data and method of enquiry

2.1 Nature and source of data

The data required for the present investigation were primary and secondary both in nature. The primary data were collected through survey method. The secondary data were collected from internet, horticultural reports and other magazines. Primary data were collected from selected farmers, retailers of chilli.

2.2 Method of enquiry

The primary data were collected by personal interview. An interview scheduled was developed as per objectives stated, for data collection each of the selected farmers was approached personally. The relevant information was gathered through pre-tested interview schedule and then the data were tabled in the light of stated objectives.

3. Period of study

The primary data in the study pertains to the agricultural year 2023-2024 and the secondary data was collected from 2005-06 to 2023-2024.

4. Analytical tool used

Suitable statistical tools were applied to analyse the data for estimating the result.

A. Costs concepts Costs A_1:

1. Value of hired labour
2. Value of bullock labour (hired + owned)
3. Tractor charges
4. Value of seed
5. Value of FYM and fertilizer
6. Irrigation charges
7. Plant protection
8. Interest on working capital

Table - 1 : Per Hectare Cost of Cultivation of Chilli

S. No.	Particular	Size of land holding			
		Marginal	**Small**	**Medium**	**Total**
1.	Human labour	55159.06 (35.46)	52788.48 (33.99)	49001.00 (32.17)	53561.08 (34.54)
	Family labour	39836.24 (26.61)	27312.87 (17.58)	13194.27 (8.66)	32222.16 (20.78)
	Hired labour	15322.82 (9.85)	25475.61 (16.40)	35806.73 (23.51)	21351.21 (13.77)
2.	Machineries charge	3842.23 (2.47)	3984.24 (2.56)	4244.81 (3.02)	3982.16 (2.54)
3.	Seed	4248.41 (2.73)	4558.21 (2.93)	4618.21 (3.02)	4394.52 (2.83)
4.	Chemical, manures & fertilizers	25160.41 (16.17)	25920.41 (16.69)	26432.41 (17.35)	25573.48 (16.50)
5.	Plant protection	13750.91 (8.84)	14532.82 (9.35)	14837.48 (9.74)	14143.18 (9.12)
6.	Irrigation channel	9332.48 (6.00)	9537.81 (6.14)	9748.32 (6.40)	9452.72 (6.08)
7.	Total working capital	111493.50 (71.69)	111321.97 (71.68)	108882.71 (71.49)	111073.48 (71.66)
8.	Total working capital (12%)	13379.22 (8.60)	13358.63 (8.60)	13065.92 (8.75)	13327.10 (8.59)
9.	Operational cost	124872.72 (80.29)	124680.60 (80.28)	121948.63 (80.27)	124401.72 (80.26)
10.	Rental value own land	15000 (9.64)	15000 (9.65)	15000 (9.84)	15000 (9.67)
11.	Interest owned fixed land (10%)	1500 (0.96)	1500 (0.96)	1500 (0.98)	1500 (0.96)
12.	Sub total	141372.72 (90.90)	141180.60 (90.90)	138448.63 (90.90)	139921.72 (90.27)
13.	Managerial cost (10%) sub total	14137.27 (9.09)	14118.06 (9.08)	13844.86 (9.09)	14089.16 (9.09)
14.	Grand total	155509.99 (100)	155298.66 (100)	152293.49 (100)	154992.41 (100)

Note: Figures in parentheses indicate percentage of the total cost

Cost A_2: Cost A_1 + rent paid for least in land.

Cost B_1: Cost A_2 + imputed on value of owned fixed capital assets (excluding land).

Cost B_2: Cost B_1 + rental value of owned land less land

Cost C_1: Cost B_1 + imputed value of family labour.

Cost C_2: Cost B_2 + imputed value of family labour.

Cost C_3: Cost C_2 + 10% of Cost C_2 (managerial cost).

Income measures:

(1) Gross income: Value of total farm output, whether sold or utilized by farm family.

(2) Net Income: Gross income. - Cost C_2 / Cost C_3

(3) Farm Business Income: Gross Income – Cost A_1 / Cost A_2

(4) Family Labour Income: Gross Income - cost B_2.

(5) Farm investment income: Farm Business Income - imputed value of family labour.

(6) Rent of owned land: Estimated on the basis of prevailing rents in the village for ideal types of land or as reported by the sample farmers, subject to the ceiling of fair rents given in the land legislation of the concerned stage (Rs. 20000/year/ha.)

RESULTS AND DISCUSSION

Per hectare cost of cultivation of chilli

The economic analysis of red chilli crop:

The economic analysis of red chilli crop, as presented in table-1, reveals intriguing patterns. Notably, the cost of cultivation per hectare of red chilli was higher on marginal farms compared to small and medium farms, with an average of Rs.154992.41 per hectare. Among the various inputs, total human labour emerged as the higher cost factor, accounting to Rs.53561.08 per hectare. Following closely was cost for chemical, manures & fertilizers (Rs. 25573.48), rental value own land (15000), plant protection (14143.18), managerial cost (14089.16), irrigation channel (9452.72), seed value (4394.52) and machineries charge (3942.16) also contributed significantly to the overall cost. The positive correlation between expenditure and yield explains the higher returns on large farms. This highlights the importance of investing in modern agricultural practices to achieve better outcomes.

Yield and cost of per quintal

Table 2 presents the yield, value of output per hectare and cost of production per quintal of chilli on the sample farms. The average yield per hectare 91, 90 and 90 quintals marginal, small and medium size farm,

Table - 2 : Per hectare yield, value of output and cost of production per quintal of chilli

S. No.	Particular	Size of land holding			
		Marginal	Small	Medium	Total
1.	Average yield (Qt./hac)	91	90	90	90.55
2.	Average price (Rs/Qt.)	4500	4600	4700	4559
3.	Gross return (Rs/hac)	409500	414000	423000	412785
4.	Cost of cultivation (Rs/hac)	155509.99	155298.66	152293.43	154992.02
5.	Net returns (Rs/hac)	253990.01	258701.34	270706.57	257789.84
6.	Cost of production (Rs/qt)	1708.89	1725.43	1692.14	1701.01
7.	Input-output ratio	2.63	2.66	2.77	2.66
8.	B:C Ratio	1.63	1.66	1.77	1.66

Source: Analysed on field survey 2023.

respectively. The overall per quintal cost of production is Rs.1708.01, with specific cost of Rs.1708.89, Rs.1725.43 and Rs.1692.14 on marginal, small and medium farms, respectively. The positive correlation between inputs value on large farms can be attributed to the increased investment in modern farm inputs.

Measures of farm profit

Table 2 the study area exhibited an overall gross return of Rs.412785 per hectare, ranging from Rs.409500 per hectare at marginal farms to Rs.423000 at medium farms. Gross returns were influenced by factors like variety, productivity and selling price. The net return per hectare averaged at Rs.257789.84, with specific value of Rs.253990.01, Rs.258701.34 and Rs.270706.57 at marginal, small and medium farms, respectively. The overall input-output ratio was 1:2.66 varying from 1:2.63 at marginal farms to 1:2.77 at medium farms.

Cost and income measures of red chilli crop in the study area:

Income from red chilli production was calculated and are given in table 3. Thegross income per hectare was observed maximum under marginal farms Rs.409500

Table - 3 : Cost and income measures of red chilli crop in the study area.

S. No.	Particulars	Size group of farms			
		Marginal (<1 ha)	Small (1-2 ha)	Medium (2&above)	Overall Average
1.	Cost A_1/ A_2	85036.48	97367.73	108734.36	92178.56
3.	Cost B_1	86536.48	98867.73	110254.36	93677.56
4.	Cost B_2	101536.48	113867.73	113867.73	108677.56
5.	Cost C_1	126372.72	126173.73	7123448.63	125901.28
6.	Cost C_2	141372.72	141180.60	138448.63	140901.72
7.	Cost C_3	155509.99	155298.66	152293.43	154992.02
8.	Product (q./ha)	91	90	90	90.55
9.	Gross income	409500	414000	423000	412785
10.	Net income	253990.01	258701.38	270706.57	257779.84
11.	Farm business income	34463.53	317632.27	314245.64	320913.30
12.	Family labour income	307963.38	300132.24	297745.75	304103.28
13.	Farm investment income	270490.01	275201.34	287206.57	274289.84
14.	Cost of production Rs. /hac.	1708.89	1725.43	1692.14	1708.32
15.	Input-output ratio	1708.89	1725.43	1692.14	1708.37
a.	On the Cost A_1/A_2 basis	1:4.81	1:4.25	1:3.88	1:4.78
c.	On the Cost B_1 basis	1:4.73	1:4.18	1:3.83	1::4.40
d.	On the Cost B_2 basis	1:4.03	1:3.63	1:3.37	1:3.79
e.	On the Cost C_1 basis	1:3.24	1:3.28	1:3.42	1:3.27
f.	On the Cost C_2 basis	1:2.89	1:2.93	1:3.05	1:2.92
g.	On the Cost C_3 basis	1:2.63	1:2.66	1:2.77	1:2.66

Source: Field survey 2023.

followed by small farms Rs.414000, medium farms Rs.423000, respectively. Productivity on these farms was associated with better management by farmers, timely cultural operations through family labours. On overall average, gross income came to Rs.412785 whereas net income was Rs.257789.84 per hectare. On overall average, farm business income, family labour income and farm investment income were worked out to Rs.320913.30, Rs.304103.30 and Rs.274289.85 per hectare, respectively. Cost of production per quintal of red chilli was computed to Rs.1708.89 Rs.1725.43 and Rs.1692.14 on marginal, small and medium farms, respectively with an overall average of Rs.208.90. On an overall average, input-output ratio on cost A_1, cost B_1, cost B_2, cost C_1, cost C_2 and cost C_3 were worked out and came to 1:4.78, 1:4.40, 1:3.79, 1:3.27, 1:2.92 and 1:2.66 respectively. Input-output ratio related to cost C_3 was highest on marginal farms (1:2.63) followed by small farms (1:2.66), and medium farms (1:2.77). In respect of cost C_2 the ratio was highest on marginal farms (1:2.89) followed by small farms (1:2.93), and medium farms (1:3.05). in respect to cost C_1 the ratio was observed highest on marginal farms (1:3.24) followed by small farms (1:3.28) medium farms (1:3.42) and. in respect to cost B_2 the ratio was found highest on marginal farms (1:4.03) followed by small farms (1:3.63), medium farms (1:3.37). While in respect to cost B_1 the input-output ratio was highest on marginal farms (1:4.73) followed by small farms (1:4.18), medium farms (1:3.83). In respect to cost $A_{1/}$ A_2 the input-out ratio was highest on marginal farms (1:4.81) followed by small farms (1:4.25) and medium farms (1:3.88) respectively.

CONCLUSION

Per hectare gross income was observed maximum under marginal farms (Rs.409500) followed by small (Rs.414000) & medium farms (Rs.423000) respectively. The gross income per hectare was highest on medium farms due to intensive cultivation and more use human labour and number of irrigation on these farms for high productivity. Productivity on these farms was associated with better management by farmers, timely cultural operation through family labour. On an average, gross income to Rs.412785 & net income Rs.257789.84 per hectare. A farm business income and family labour income were worked out to be Rs.320913. 30 and 304103.30 per hectare, respectively. Cost of production per quintal of gram was computed to Rs.1708.89, 1725.43 and 1692.14on marginal, small and medium farms, respectively.

Input-output ratio related to Cost C_3 was highest on medium farms 2.77 followed by small farms 2.66 and marginal farms 2.63. Under marginal and small farms. Overall average cost of production per quintal was Rs.1708.02.

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WATER BAITING: A SOIL LESS PATHOGENICITY TEST FOR SOIL-BORNE FUNGUS

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ABSTRACT

Disease symptoms which are characteristic features in detection and diagnosis of plant pathogens. During pathogenicity test proper symptomology helps to identify pathogen for recommendations of the management practices, the pathogenic races differential ability of virulence under soil-based tests are difficult to observed for long run of germplasm screening. The present study confronts symptomology and pathogenicity test of three different soil borne fungus *Fusarium solani*, *Rhizoctonia solani* and *Pythium aphanidermatum under* soil less and soil-based methods to know the extent of their virulence capacity under both conditions on three different crops Chilli, Brinjal and Tomato with severe cause of damping off , Fusarium and *Rhizoctonia spp* are quick infective pathogens which symptoms have been initiated immediately after 3 days of inoculation and highest mortality was observed by *Phytopthora* spss.

Keywords : *Fusarium and rhizoctonia spp, phytopthora spp*

INTRODUCTION

Plants are being exposed by continues threatening from many plant pest and disease according to the Secretariat of the International Plant Protection Convention (IPPC) under the FAO , delay in measurement actions against these menace will have to pay a huge debt ecologically and economically, global estimated losses due pest and disease were estimated 20 to 40 percent (Kourous, 2016) and the targeting with 14 percent of damage by plants disease accounts for $220 billion dollar losses in agriculture trade (Khakimov et al., 2022).Plant disease are detected and diagnosed through many techniques which are cultural methods, based on symptomology of host, serology and molecular techniques (Martinelli et al., 2015). Present scenario 83 percent of plant infectious disease are caused by fungi ,9 per cent by viruses and phytoplasmas, and 7 percent by bacteria (Khakimov et al., 2022). The effective management of disease was successful priorly with identification of pathogen otherwise improper idenfiction leads to misleading management strategies with crop losses. Assessment of crop losses were done based on different disease parameters with specified damage symptoms and these symptoms are important for combating them with proper diagnosis based on its symptoms (Narayanasamy, 2011). Many types of common plant disease include rotting, withering or wilt, staining, gall formation, tumours deformity, mosaic, vein clearing different symptoms which are specific to the pathogen. Softened plant tissues with decayed plant parts with rotten smell and easily breakdown was specified by fungal pathogens

Pythium, Phytopthora, Fusarium, Sclerotinia, Rhizoctonia spss (Kowalska, 2021) as well as bacteria such as *Pectobacterium carotovorum, Xanthomonas campestris (Slack et al., 2017).*Soil borne pathogens are opportunistic in nature and they are highly pathogenic with complex interactions of other biotic factors (Smolińska and Kowalska, 2018).Majority of soil bone fungal species attack the vegetable crops at very young seedling stage caused damping off these damping occur during preemergence and postemergence in stage lead to mortality of seedings (Tziros and Karaoglanidis, 2022). Pathogenicity test can be performed by isolation the pathogen and inoculation by classic pure culture method general procedure of isolating the fungal plant pathogens. Detection of pathogenic mycelium and spores which grown on media, characteristic microscopic observations are helpful for fungal identification (Dyakov and Elansky, 2019). Different types of inoculation steps were used to detect the pathogenicity of Phytopthora species such as, leaf inoculation with two zoospore concentrations at three different temperatures and stems were inoculated using agar plugs and susceptibility was determined by reisolating and lesion length (Davis et al., 2021). The present research was aimed to test the pathogenicity of three different fungal pathogen under liquid substrate under after inoculation of pathogens and their effectiveness in demonstrating the pathogenicity and symptoms.

MATERIALS AND METHODS

Pure culture of pathogens

Isolation of fungal pathogens from the infected seedlings sample was carried by tissue isolation method. Fungal colonies developed were examined and sub cultured. Based on morphological characters published literature the fungi were identified as *Fusarium solani*, *Rhizoctonia solani* and *Pythium aphanidermatum*. The pure culture was transferred on PDA slants and maintained for further studies

Water suspension of pathogens for pathogenicity of seedlings

Pure culture of *Fusarium solani*, *Rhizoctonia solani* and *Pythium aphanidermatum* were used to determine pathogenicity. Surface-sterilized (5 min in 2.5 per cent sodium hypochlorite) seeds of the susceptible brinjal were sown in autoclaved sand in 15-cm pots. Approximately 1 kg of sand was placed in each pot. The seedlings raised were used after 20 days of germination. Potato-dextrose broth (peeled and sliced potato, 200 g; dextrose, 20 g; distilled water, 1000ml) was prepared, 100 ml of broth was added in each 250 ml conical flask and autoclaved at 15 lbs. for 20 min. The broth was then inoculated with a bit of the fungus isolates from tubes and incubated on a shaker (8 hrs. each day) at room temperature (25-30°C) for 10 days. The entire contents of flask were diluted with sterilized distilled water to get the final inoculum dilution of 2.5% (usually about 2.5 litres of water was added to attain the desired dilution of the contents of one flask). This will ensure approx. 6.5×10^5 spores/ml. Then 20 ml of diluted inoculum was added into each sterilized 150 x 15 mm glass test tube. The 20-day old (from sowing) seedlings from sand were removed and the root system was washed under running tap water and then rinsed in sterilized distilled water. Then one seedling into each tube was placed by holding it in position by a cotton plug. Sterilized distilled water was added to the tubes after every 2 days to make up the loss. Ten seedlings were used to serve as check/ absolute control. Tubes were kept in a test tube stand to hold them in position. Observations were recorded 15 days after inoculation.

Soil inoculated pathogenicity test of seedlings

Three different isolates *Fusarium solani, Rhizoctonia solani* and *Pythium aphanidermatum* causing damping off were multiplied on sorghum grain media. Fungal inoculum 5 per cent by volume was mixed and pots were filled with soil and sand in the 3:1 ratio. These pots were kept in green house of Department of Plant Pathology, Dr. PDKV Akola. After 7 days of inoculation 40 brinjal (PDKV-Aruna) seeds were sown per pot, pathogenicity tests of this pathogen were employed, five pots for each isolate and for absolute control (without any pathogen) were used. The pots were covered with polythene sheet for 48 hours to avoid contamination and watered at regular intervals to maintain humidity. Pathogen reisolated from experimentally diseased seedlings and grown in pure culture pathogenicity was proved.

RESULTS AND DISCUSSION

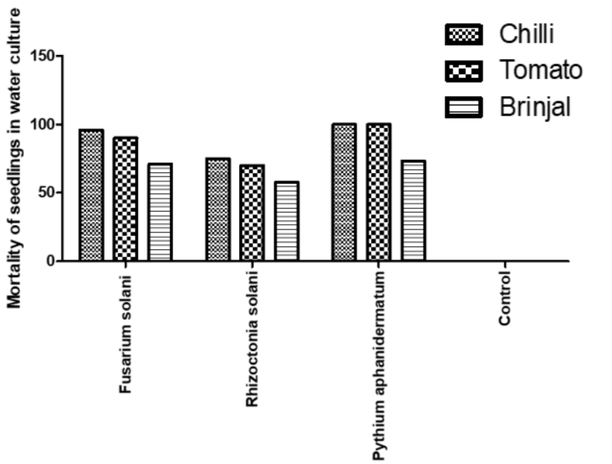
Pathogenicity by water culture method

Water culture method, isolates of *Fusarium solani*, *Rhizoctonia solani* and *Pythium aphanidermatum* were cultured on 100 ml PDB respectively and mixed with 2.5 litres of distilled water and desired spore count of 6.5×105 spores/ml was achieved. The spore suspension of nearly 20 ml was poured in 10 sterile glass test tubes for each pathogen. Surface sterilized 10 days old healthy seedlings of a susceptible brinjal variety were placed inside each test tube and the observations were recorded 10 days after inoculation which showed damping off symptoms. This method gave the conformation about the ability of pathogens to cause disease. Seedlings inoculated with the *Pythium aphanidermatum* showed almost 100 per cent symptoms of damping off when compared with the other two isolates *Fusarium solani* and *Rhizoctonia solani,* which showed 90% and 70% of disease symptoms on the healthy seedlings of brinjal respectively over the absolute control. Similar observations were recorded by Sibtain et al. (2001) in which chickpea seedlings inoculated by Fusarium oxysporum *f. sp. ciceris* showed 100% disease symptoms.

Pathogenicity by pot culture method Damping off pathogens Fusarium solani, Rhizoctonia solani and Pythium aphanidermatum were taken to prove pathogenicity test. For that pot culture experiment was conducted under greenhouse condition. Soil inoculated with pathogens and sand (3:1) was prepared and filled in pots for Fusarium solani, Rhizoctonia solani and Pythium aphanidermatum isolates respectively and forty seedlings were kept under observation. The inoculated and uninoculated control pots were maintained under controlled environmental conditions. Fusarium solani showed both pre and post emergence damping off symptoms on 38 seedlings where Rhizoctonia solani and *Pythium aphanidermatum* showed disease symptoms on 35 and 37 seedlings respectively form the total seedlings under observation over the control with no disease incidence. In pre-emergence damping off, seeds were rotted and in post emergence damping off, seedlings showed toppled over symptom due to infection at collar region.

Table 1. Number of days recorded symptoms in under water culture technique and Pot culture under soil conditions for detecting pathogenicity

Chilli	Water culture techniques	Pot culture under soil conditions
Fusarium solani	96	89
Rhizoctonia solani	75	80
Pythium aphanidermatum	100	76
Control	0	0
Tomato		
Fusarium solani	90	95
Rhizoctonia solani	70	87.5
Pythium aphanidermatum	100	92.5
Control	0	0
Brinjal		
Fusarium solani	71.1	75.5
Rhizoctonia solani	57.7	73.3
Pythium aphanidermatum	73.3	62.2
Control	0	0



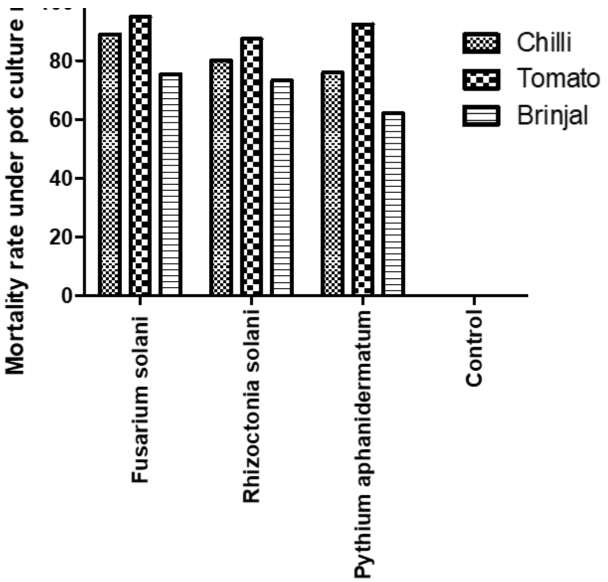


Fig. 2 : Graphical representation of days mortality in under water culture technique and soil based for detecting pathogenicity.

Table 2. Number of days recorded symptoms in under water culture techniques for detecting pathogenicity

Crop	Days to symptoms			
Chilli	DAY 3	DAY 5	DAY 7	TOTAL
Fusarium spp.	2	3	4	9
Rhizoctonia solani	1	3	4	8
Pythium spp.	0	4	5	9
CONTROL	0	0	0	0
Brinjal	DAY 3	DAY 5	DAY 7	TOTAL
Fusarium spp.	2	3	5	10
Rhizoctonia solani	1	4	4	9
Pythium spp.	0	2	5	7
CONTROL	0	0	0	0
Tomato	DAY 3	DAY 5	DAY 7	TOTAL
Fusarium spp.	1	3	4	8
Rhizoctonia solani	2	3	4	9
Pythium spp.	0	4	4	8
CONTROL	0	0	0	0

From the above table 1 and 2 it had been revealed that different response of seedlings to virulence nature of the three different pathogens in both soil and water culture techniques. Mortality rate of the seedlings under *Pythium aphanidermatum* in water culture techniques was highest in three different crops 100 percent in both chilli and tomato and 73.3 in *Brinjal. Fusarium solani* shows mortality rate of 96, 90 and 71.1 in Chilli, Brinjal and Tomato. *Rhizoctonia solani* shows a mortality rate of 75, 70 and 57.7 in chilli brinjal and Tomato.

Appreance of symptoms during the pathogenicity test show the virulence of the pathogens during water culture three different crops chilli shows the *Fusarium spp.* Initiated the symptoms on tender seedlings from 3 days after inoculation tat end of 7 days 9 seedlings were affected, *Pythium spp.* symptoms were initiated at 5 days after inoculation and finally 9 seedlings were infected in chilli. Brinjal crop highest infection of seedlings observed under *Fusarium spp* and symptoms were initiated at 2 days of inoculation later followed by *Rhizoctonia solani* 1 day after inoculation where as in Pythium symptoms were initiated at 5 days after inoculation. In tomato damping of symptoms appeared from 3 days after inoculation for both *Fusarium spp* and *Rhizoctonia solani*. How ever the initial symptoms for *Pythium spp.* were slow when compared to the other damping of pathogens. Disease symptoms which are crucial for the assessing the host susceptibility gives a brief description for host range studies, different screening techniques has been under evaluation for testing the pathogenicity. Field techniques for large-scale investigations of the pathogenicity may be complicated to carry out race identification and inheritance studies of different plant pathogens .Indirect methods of pathogen detection identify plant diseases through different morphological change in seedlings (Fang and Ramasamy, 2015).Soil less methods in detecting the pathogenicity always give an effective way of detecting virulence in pathogens the soil less water culture technique was used to test the pathogenicity for different isolates in chick pea plants (Nene et al., 1991) .Screening of advanced lines of chick pea for effective virulence against *Ascochyta rabiei* and *Fusarium oxysporum* through water culture techniques (Jamil et al., 2002).

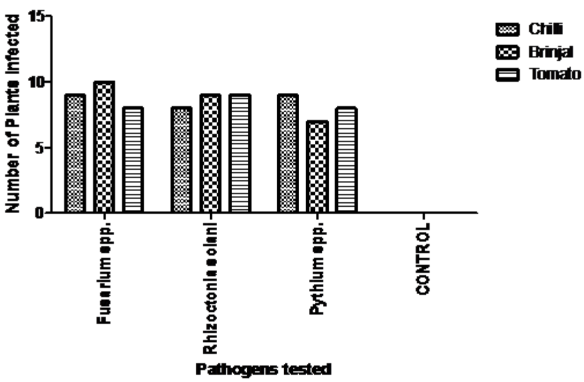
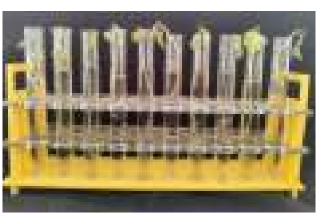


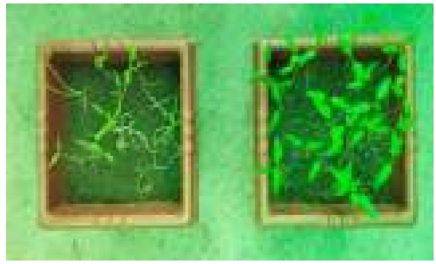
Fig. 2: Graphical representation of days recorded symptoms in under water culture techniques for detecting pathogenicity




Tomato **Brinjal**

Chilli

Fig 1: Soil less water culture technique Pathogenicity against Chilli, Tomato and Brinjal



Tomato

Brinjal

Chilli

Fig 2. : Soil based pathogenicity against Chilli, Tomato and Brinjal

Fusarium oxysporum

Rhizoctonia solani

Pythium aphanidermatum

CONCLUSION

Pathogenicity test against host to detect the virulence nature important prospects in postulating the pathogenicity effectiveness. Soil less and soil-based substrates were used in detecting the pathogenicity tests but high level of screenings against wide range of well suited for race studies and quick assessment of virulence nature of pathogens when compare to the soil-based pathogenicity test.

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CONTRACT FARMING AND MARKET DEVELOPMENT IN INDIA: A REVIEW

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ABSTRACT

This study tries to evaluate the progress of contract farming in India over the period of time. As the farmers are switching towards the contract farming which reveals that farmers are efficient adaptor of this farming. The tools for the growing associated industrial base, exports and a fair and equitable global system for the farming community needs an agricultural model unconventional workable, "Commitment-driven Contract Farming". The data reveals that several international and Indian companies have already started contract farming in India, while most of them have successfully started operations. However, their success depends on a viable market, physical and social environment and especially the active involvement of government entities that play a key role in contract farming. Overall, the future of Indian contract farming looks bright given the positive trends in the fast-growing middle-class organized retail sector and the food safety requirements of developed country export markets.

Keywords : *India, contract farming, positive trend, market.*

INTRODUCTION

Producing and selling on a contractual basis is a common arrangement in agriculture all around the world. Contract farming has existed for a long time, particularly for perishable agricultural products delivered to the processing industry, such milk for the dairy industry or fruits and vegetables for making preserves. At the end of the 20th century, contract farming has become more important in the agricultural and food industries of the developed and developing countries. Spurred by changes in (international) competition, consumer demands, technology, and governmental policies, agricultural systems are increasingly organized into tightly aligned chains and networks, where the coordination among production, processing and distribution activities is closely managed. Contracting between producers on the one hand and processing or marketing agribusinesses on the other hand is one of the methods to strengthen vertical coordination in the agrifood chain.

CF has been defined as an agreement between one or more farmer(s) and a contractor for the production and supply of agricultural products under forward agreements, frequently at predetermined prices (Eaton and Shepherd, 2001). The US Department of Agriculture defines contract farming as “the growing and marketing of farm products under such circumstances that selective terms of the market-quantity, grade, size, inspection, timing, or pricing are specified to both the grower and the processor or shipper before production is undertaken. The contractor can be a processing firm or a trading/marketing firm; it can be a private or a public entity. The agreement often includes the provision of production support by the contractor, such as inputs and technical assistance. The basis of a CF arrangement is a commitment on the part of the farmer to provide a specific commodity in quantities and at quality standards determined by the contractor and a commitment on the part of the contractor to support the farmer's production and to purchase the commodity.

Economic Rationale for Contract Farming

All markets require some form of vertical coordination—that is, matching of supply and demand between different participants in the marketing channel, such as farmers, processors, wholesalers, and retailers. Economic logic would suggest that well-informed farmers will not voluntarily enter into contracts with buyers unless they believe there will be benefits. However, the actual impact may be negative because of misperceptions or lack of information. If the contract-farming scheme involves tree crops or other transaction-specific investments, farmers may be locked into an arrangement that is not beneficial. Early reviews of the literature concluded that most studies suggest that farmers benefit from contract farming because it provides them with inputs on credit, technical assistance, and often a guaranteed price, allowing them to produce a higher-value commodity than would otherwise be possible (Glover 1984; Minot 1986). Little and Watts (1994) provide a more skeptical view of the benefits of contract farming based on a set of seven case studies of contract farming in Africa south of the Sahara. These studies focus on conflicts between farmers and the contracting firms, the imbalance of power between the two parties, intra household tensions over the division of labor and new revenue, and increasing rural inequality. Similarly, Porter and Phillips Howard (1997) conclude that contract farming generally raises farmer incomes, but may also cause social problems.

Table - 1 : State wise Contract Farming initiatives by private companies in India

State	Company	Crop
Karnataka	Himalaya Health Care Ltd.	Ashwagandha
	Mysore S N C oil Co.	Dhavana
	AVT Naturals Products Ltd.	Marigold and Caprica Chilli
	Natural Remedies Pvt. Ltd.	Coleus
	20 Pvt. Companies	Gherkins
	Rallis India	Cotton
Maharashtra	Tinna Oil and Chemicals	Soyabean
	Rallis India	Basmati, Wheat, Fruits, Vegetables
	ION Exchange Enviro Farms Ltd.	Several Fruits, Vegetables, Cereals and Pulses
Madhya Pradesh	Cargil India Ltd.	Wheat, Maize And Soybean
	Hindustan Lever Ltd	Wheat
	ION Exchange Enviro Farms Ltd.	Several Fruits, Vegetables, Cereals and Pulses
	ITC	Soyabean
Punjab	NIJJER Agro Food Ltd.	Tomato And Chilli
	United Breweries Ltd.	Barley
	Satnam Overseas, Sukhjit Starch	Basmati, Maize
	Satnam Overseas, Amira Indian Foods Ltd.	Basmati
	PepsiCo India Ltd.	Basmati, Groundnut, Potato And Chilli
Tamil Nadu	Super Spinning 570 mills	Cotton
	Bhuvi Care Pvt. Ltd.	Maize
	Appachi Company	Cotton

Conditions to benefit Small farmers

Dorward *et al.* (1998) have identified a number of conditions related to the structure of the market which have to be fulfilled before interlocking contracts (i.e., contracts with a focus on providing credit) can be beneficial for both contractor and (small) farmers:

There must be strong demand for the crop output (i.e., a sellers' market), providing incentives to engage in CF to those traders who have access to capital. This will normally be associated with traders making investments in some form of specific assets in crop trading, an investment which needs to be serviced by a high turnover. Specific assets may include investments in plants (such as in processing) or in a special relationship (including reputation) with a large retailer or exporting company.

There must be competition among traders, to prevent farmers being locked into unequal relationships with a particular trader.

Farmers must face effective repayment incentives, which means that they incur a loss of earnings if they default on a loan. This requires that the crop provides them with better returns than other income earning opportunities. In a situation where traders are competing for farmers' business, there then needs to be either (a) effective exchange of information on farmer reputations, or (b) specific investments by farmers in establishing trust with a particular trader over a period of time.

Governments may play two important roles in ameliorating the negative effects of CF (Eaton and Shepherd, 2001; Simmons, 2002). First, the state may act to regulate the market ensuring that contractors do not abuse their market power. the state may facilitate contracting by encouraging agribusiness firms to initiate new contracts and providing support to smallholders to make them suitable for contract selection. Such facilitating activities may include the provision of training (for instance in negotiation), extension services providing information on pros and cons, and research on CF practices and their impact. But also providing more information on markets and prices may greatly support the position of smallholders when entering CF schemes. Finally, direct subsidies to smallholder may be helpful. Glover and Kusterer (1990) report that smallholders with contracts were subsidized in the early years of their participation to reduce yield risks. In South Africa, the Black Economic Empowerment in Agriculture (AgriBEE), with the goal of ensuring black people's improved access to productive resources and full participation in the agricultural sector, supports the establishment of contract between black smallholders and contractors (Sautier *et al.,* 2006). Another condition relates to power distribution between producers and contractor. Given the large differences in resource endowments between smallholders and contractors, CF arrangement tend to be characterized by an unbalanced power relationship. This may easily lead to exploitation of the powerless by the powerful (Little and Wattts, 1994). Glover (1987), Porter and Phillips-Howard (1997), and Warning and Key (2002) provide a number of recommendations for preventing skewed power relations.

Some studies examining the impact of Contract farming on Incomes or revenues

Little and Watts (1994) concluded case-study analysis of several schemes in Africa. Concludes that incomes increased for a moderate to high proportion of farmers, but highlights range of problems including conflicts between farmers and the contracting firms, the imbalance of power, intrahousehold tensions, and rural inequality.

Singh (2002) reviewed various schemes in India and Focuses on problems of power imbalance between farmers and firms, violation of terms, and social differentiation, but also finds higher incomes and satisfaction with participation in contract farming schemes.

Birthal, Gulati, and Joshi (2005) found that most dairy and vegetable farmers would prefer to grow under contract, but most poultry farmers would not. Contract poultry growers tend to be less experienced and leave scheme when they become more experienced.

Birthal et al. (2008) concluded that contract dairy production is more profitable than independent contract production, mainly because of the lower transaction costs associated with contract production. A treatment-effects model suggests that participation in contract production increases net revenue more than 80 percent compared to the average.

Narayanan (2014) found that participation in contract farming estimated to have increased profits of gherkin farmers by 21 percent, papaya farmers by 32 percent, poultry farmers by 150 percent. Contract farmers in marigold earned 49 percent lower profits than they would have outside the scheme.

Harish (2020) revealed that, about the level of major strength, it is seen that the majority (17.50%) of respondents said that fixed price is the major strength of contract farming. It is also evident that the majority (12.50%) of respondent's major weakness of contract farming is the rejection of crop, most (10.00%) of the respondents, major opportunities of contract farming, are job opportunities. A majority (14.06%) of respondents, major threats of contract farming, is no compensation for their crops, while any risk happened.

Paltasingh, K. R., et al.(2023) suggested that marginal and small farmers are involved under CF in a very negligible percentage (9.32%) as compared to medium (32.79%) and larger farmers (57.89%). From a long-term perspective in terms of agricultural market involvement, their exclusion from contracting technology cannot be overlooked as around 68% of total farmers' population in Haryana and around 80% of total farmers' population in India is belonged to this category. So, the study suggests that contracting firms should bring the marginal and small-scale farmers into the ambit of the contract to uplift their well-being. Institutional and structural barriers to CF adoption by these farmers should be eliminated on both the supply (farmers) and demand (contracting firms) sides. So, the study suggests that contracting firms should bring the marginal and small-scale farmers into the ambit of the contract to uplift their well-being.

Stages of Market Development and Contract Farming

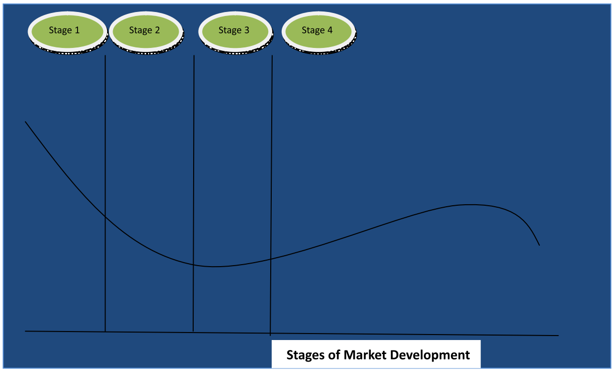
Stage 1. Transformation from subsistence to commercial agriculture: the main function of contract farming is facilitating transformation from subsistence to commercial farming.

Stage 2. Development of agro-industry and crop diversification: contract farming is essential in the growth and development of the agro-processing industry.

Stage 3. Mass production and spot market transaction: the market functions well, and the importance of contract farming is relatively limited.

Stage 4. Product differentiation and globalization: contract farming functions as an institution to address market failures associated with product attributes in the globalized market.

Figure - 1 : Stages of Market Development and Contract Farming



Concerns of Contract Farming :

Although there is a range of benefits in contract farming, like Cost efficiency , Quality management, consistency, reduced risk it is by no mean a panacea to agricultural commercialization and poverty reduction. Several concerns have been raised regarding the desirability of contract farming from a poverty and equity standpoint, foremost of which involves the opportunistic nature of such arrangements. The major concerns are discussed in this section.

A. Monopsony Control Contract farming as a development tool has been criticized for the exploitative effects of monopsony control, whereby farmers are tied to one purchaser (Grosh, 1994). The firms generally possess more information, resources, and organizational ability than small farms. Their strong bargaining position enables them to potentially extract significant rents from smallholders, leaving them only marginally better off. Many examples reveal farmer vulnerabilities whereby their bargaining power is reduced due to coercive contractor practices (Little and Watts, 1994). Once farmers invest in new crops and production to adhere to contractual requirements, financial and time constraints render them unable to easily switch to other types of crops (for example, tree crops take a long time to establish and grow). Lacking alternatives, farmers become dependent upon buyers, and firms are then able to elicit more self-serving contract terms. In addition, the transition from subsistence farming to cash crop production has the potential to render households vulnerable to food shortages and nutritional loss. Many contract farming arrangements are based on monocropping of a non-traditional crop, causing farmers to become reliant on income from the sole cash crop. If the firm does not live up to its the contractual obligations, farming households may thus be vulnerable, since they no longer grow a variety of edible crops and lack the funds to purchase food (Key and Runsten, 1999).

B. The Burden of Labor Management Although contract farming may reduce the cost of labor management for the agro-business firm, the burden of labor management is in fact transferred to the poor farm households. The act of purchasing directly from farmers rather than hiring wage workers shifts the burden of labor recruitment and control onto the producer (Baumann, 2000). In this respect, although agro-business firms may benefit from reductions in labor management and land cost, such practices may also lead to exploitation since family labor is inclusive of women and children. White's (1997) study of dairy contract farming ventures in West Java determined that in “family” run dairy farms women and children provided an estimated 60% of all labor inputs (White, 1997). However, contractual agreements are often signed and the proceeds controlled by the male head of the household. The burden of farming practices may be placed on the most vulnerable members of the household.

C. Contract Enforcement Many developing countries lack the laws and ensuing legal framework to support contractual agreements. Agreements themselves may not be easily enforceable or legally binding. Opportunism on the part of both parties can result. In most developing countries contract farming arrangements are operated in accordance to traditional values and norms rather than legal agreements (Glover and Gee, 1992). In the absence of legally binding contracts, firms can suffer from the effects of extracontractual sales of outputs (Eaton and Shepherd, 2001). Contract default by farmers often increases with a rise in the number of willing purchasers. When alternative markets develop and competing buyers offer competitive prices, farmers are given the incentive to break their contracts, often failing to repay input credit to the contractor (Coulter et al., 1999). The absence of an effective legal system and the lack of collateral held by small farms can result in considerable risks for agro-business firms. An issue involving input diversion occurs when farmers are tempted to use inputs supplied by the firm for non-intended purposes (Eaton and Shepherd, 2001; TDRI, 1996). Much can be done to mitigate the opportunistic behaviors of both contractual parties. At the local level, farmer organizations and NGOs can play a pivotal role in protecting farmer assets by establishing their own systems for quality management, input production (fertilizers), traceability, and, if possible, certification (IFAD, 2005). Local government bodies and NGOs can ensure a firm's capacity to offer profitable contracts to farmers prior to the establishment of agreements by checking a contracting firm's financial and managerial capacities.

D. Bias Toward Large Farms One criticism of private-led contract farming is that agro-business firms favor large-scale farmers (Key and Runsten, 1996). Agro-business firms may be motivated to seek contracts with larger farmers to reduce transaction costs and allow for the procurement of more uniform products (Baumann, 2000). In this respect, the cost of managing a large number of small farms may indeed influence a firm's decision to establish such relations. Nevertheless, in the context of developing countries, contract farming with small farms has proven successful in some instances. Agro-business firms prefer limited land size to ensure easier maintenance and greater quality control over a given crop as is the case with asparagus and cucumber farming in Thailand. Often smallholders can produce a high-quality, labor-intensive crop if given the appropriate technical supports. Nevertheless, although contract farming appears to involve small farms, such arrangements may exclude the poorest of the poor. Landless peasants and households possessing only limited marginal lands tend to be overlooked by firms.

CONCLUSION

Based on review of the literature, contract farming appears to be a promising institutional arrangement to facilitate farmers' access to an array of agricultural services from which they are typically excluded. Contract farming enhances the agricultural productivity and efficiency of poor farmers by introducing improved farming practices through the provision of inputs, transportation, extension services, and, most importantly, market access. It also brings investments and technical expertise to rural areas, facilitates cross-border quality control, contributes to employment, and fosters sustainable cooperation within the region. Though this review focused primarily on GMS transition economies, the potential benefits of contract farming are relevant in the broader context of other developing countries. This review highlights the strong potential uses of contract farming in the following context:

1. As a development tool in facilitating the transition from subsistence production to commercial production.
2. In facilitating growth of the agro-

processing industry to add value to primary products.

3. In facilitating crop diversification through transition from conventional, low-cash crops to high-value crops for niche market in domestic and export markets.

4. In fulfilling new stringent trade requirements for export market. Although it appears that contract farming can potentially lead to large-scale rural poverty reduction, there are several concerns that need to be addressed by the public sector. The concerns are perhaps best discussed in the general context and also in the context of different stages of development.

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AN ECONOMIC ANALYSIS OF MILK PRODUCTION IN HARDOI DISTRICT OF UTTAR PRADESH

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ABSTRACT

An attempt has been made in the investigation to study the economic analysis of milk production with primary data obtained from 100 milk producers in Hardoi District of Uttar Pradesh. The study revealed that the cost of production of milk was ₹ 31.85 and ₹ 29.27 respectively in case of buffaloes and cows. The gross returns were found to be highest in case of cows as compared to buffalo since the later are genetically poor yielders. The cows are are potentially high yielders with better management practices. Dairy unit has employment potential for both family labour across different farm size group of marginals, small and medium farmers. The net return after meeting out the cost of production was found to be highest in case of buffaloes and cows. The cost benifit ratios have demonstrated profitability of rising cows on all the farm size groups.

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Keywords : *Economic analysis, cost of milk production and net income.*

INTRODUCTION

India is endowed with the largest livestock population in the world. It accounts for 20.5 per cent (109.82 million) of the world's buffalo population and 36 per cent (193.46 million) of cattle population. The total milk production in country has increased from 17 million tones in 1950- '51 to 230.58 million tones in 2022- 2023 (Basic Animal Husbandry Statistics, 2022- 23). Consequently, per day per capita milk availability has increased from 112 gms in 1950- '51 to 459 gms in 2022-2023 (Basic Animal Husbandry Statistics, 2022- 23). Milk production in the country is increasing at an annual growth rate of 3.83 per cent (Basic Animal Husbandry Statistics, 2022- 23). The remarkable increase in milk production has been due to launching of Dairy Development Programmes with collaborative effort of the central and state government.Dairying is the backbone of the marginal farmers and labourers spread over numerous villages scattered throughout the country. It is primary source of income and employment for many of India's poor. This sector can play an important role in determining future prospects for the employment generation and poverty alleviation in the country. This sector is closely interwoven with agriculture. Performance in dairying sector is, therefore, expected to influence growth in the rural economy. Unlike many developed countries where dairy farms have become giant factories serving the umbilical cords linking households and production. Dairying in India is a small holder milk production enterprise and is highly integrated with the crop production sector. The feed for milch animals is largelydependent on the crop residues and agro-industrial bio- products and contribute in return milk for crop production. Milk production in India is a low output farm activity wherein about three-quarters of rural households own one to three milch animals. Income from dairying, which often helps tide over unforeseen demand for liquid cash, contributes nearly one-third of the rural household's gross income and in case of landless wage earning households nearly half. There are two important secrets behind this success, first, the introduction of efficient milk production pattern integrated with agriculture and second, involvement of milk producers at various levels for procuring, processing and marketing through dairy co-operatives.

Uttar Pradesh largest milk producing state in the country contributes 15.72% to the total milk production in India. The total bovine population is 68036 thousand comprising of 9207 thousand cows and 15732 thousand buffaloes (20th Livestock Census, 2019). State has largest number of Dairy Co-operative Societies (44222) standing on sixth rank among state. Per capita milk availability in the state is about 426 gms./day (State/UN Animal Husbandry Department, 2022-2023).Uttar Pradesh consists of 75 districts. Hardoi has been selected purposively for the study entitled "Economic analysis of Milk Production in Hardoi District of Uttar Pradesh". The selection of district was mainly due to large number of bovine population (1650285) and milk co-operative societies (43460) GoI Ministry of co-operative 2023, and also having good infrastructure facilities for veterinary and animal husbandry services. Secondly, no study has so far been conducted in this district. In addition to this, the researcher is familiar with the local language, prevailing socio-economic condition and customs of the area enabling him to elicit the required information for the study.

MATERIALS AND METHODS

The study was undertaken in Hardoi district of Uttar Pradesh state. It is based on primary data obtained from 100 milk producers of five villages since these accounted for about 50 per cent of total population of milk producers of Hardoi district. A list of leading milk producing villages was obtained from concerned government departments and three villages from each Taluk were selected at random. For selection of milk producers, a list of milk producers owning at least one crossbred or local cow or buffalo was obtained from village level extension workers of respective villages. From the list, 100 milk producers from each village were selected at random. Thus, the sample consisted of three five villages and 100 milk producers (20×5=100). The primary data were collected from sample household by conventional survey method using well-structured schedule through personal interview.

The data were collected on various aspects of dairy enterprises like, composition of household, occupation, sex, family size, education of head of family, operational holding, herd size, type of animals and their value, dairy equipment, cattle shed along with their present value and expected life, quantity of feeds and fodders fed to animals along with their prevailing prices, family and hired labour used along with prevailing wage rate, veterinary and miscellaneous expenditure.

Theinformation on milk production, its selling price, marketed surplus and disposal pattern were also collected.

RESULTS AND DISCUSSION

The findings obtained from the present study are presented below:

General characteristics of sample farmers:

The general information of selected milk producers regarding education, size of the family and occupation is presented in Table 1. The sample size consisted of 100 milk producers with breakup of 63 marginal,31 small and 6 medium milk producers. This indicated that the farmers were in the middle age group with experience in dairy farming. Education is another important influencing managerial ability. As is evident from the table that educational score was 70 per cent indicating that sample milk producers had better educational status which enabled the dairy farmers to manage their units. The average size of the family was 6 persons. The size of the family affects milk production and consumption. The family size contributes to supply of family labour for management of dairy unit. Dairy enterprise was taken up as a subsidiary occupation with agriculture as the main occupation by all the respondent farmers. It was also observed that the average landholding of farmers was 1.28 ha. marginal, 3.16 ha. small and 5.41 ha. medium farmer categories.

Size of dairy unit:

It is observed that the livestock population was 154 animals. Of this, 89 cows and 154 buffaloes. The average number of livestock maintained was in the order marginal, small and medium farmers. It is heartening to note that in all the categories of farmers, the number of buffaloes were mor than the cows. However, on marginal farms, the number of buffaloes and cows was more than the indicating that marginal farmer depend on local breeds for milk production. The value of livestock was found to be higher in case of large farmers at ₹ 5796853/- (Table 2).

Investment in dairy :

Table 3 portrays the investment details on dairy enterprise by the sample farmers. Investment in dairy comprises of investment in milk animals, cattle shed and dairy equipments. The investment in dairy varied across the different size groups. The per form investment was estimated to be □14605200/-. The investment was maximum in case of Marginal farmers with □ 6917464/- while it was lowest among Medium farmers (27,45364-). It is significant to observe that the investment on dairy animals accounted for big chunk of the total investment with 83.80 per cent, 80.54 per cent and 78.54 per cent, respectively in case of Marginal, Small and Medium Farmers categories.About 12.15 per cent of the total investment was made on Cattle shed. The shed constructed by farmers was pucca/ kaccha building but instead constructed using locally and machinery available materials. Hence the investment was so much.

Table - 1 : General information of selected milk producers

S.No.	Particular	Size group			Overall
		Marginal	Small	Medium	
1	No. of milk producers	63.00	31.00	06.00	100
2	Education level	24.50	08.20	06.00	12.90
3	Family size				
	Male	03.06	03.40	03.24	03.28
	Female	02.30	03.20	02.71	02.73
	Total	05.36	06.60	06.11	06.04
4	Occupation				
	Main agriculture	44.00	30.00	03.00	25.66
	Subsidiary	44.00	30.00	03.00	
5	Land holding (ha)	01.28	03.16	03.28	03.28

Table - 2 : Size of the dairy unit numbers

S.No.	Categories of the livestock	Size group			Overall
		Marginal	Small	Medium	
1	Cows	54.00	22.00	13.00	89.00
2	Buffaloes	93.00	53.00	08.00	154.0

Table - 3 : Investment in dairy enterprises (₹/Farm)

S.No.	Particulars	Size group			Overall
		Marginal	Small	Medium	
1	Milch animals	5796853 (83.80)	3985322 (80.65)	3985322 (78.54)	11938000 (81.75)
2	Cattle shed	703258 (10.16)	598423 (12.10)	473519 (17.24)	1775200 (12.15)
3	Dairy equipment	417353 (06.03)	358627 (07.25)	116020 (04.20)	892000 (06.10)

Table - 4 : Maintenance cost per milking buffalo per day (₹)

Cost components	Land holding category			Overall
	Marginal	Small	Mediu m	
Green fodder	50.01 (19.10)	54.68 (21.60)	60.56 (24.15)	55.08 (21.61)
Dry fodder	68.37 (26.11)	67.29 (26.58)	60.09 (27.56)	68.25 (2674)
Concentrate	41.53 (15.86)	38.48 (15.20)	39.87 (15.90)	39.96 (15.65)
Total feed cost	159.91 (61.07)	160.45 (63.38)	169.54 (67.60)	163.30 (44.01)
Family labour	49.51 (18.91)	46.93 (18.54)	45.80 (18.28)	47.41 (18.57)
Miscellaneous expenses	05.31 (02.03)	05.24 (02.07)	06.84 (02.73)	05.79 02.6)
Total variable cost	214.72 (82.00)	212.63 (83.99)	222.20 (88.60)	216.51 (84.86)
Depreciation on fixed capital	21.72 (08.73)	20.75 (08.20)	18.81 (07.50)	20.43 (08.00)
Interest on fixed capital	25.40 (09.07)	19.77 (07?81)	09.78 (03.90)	18.31 (07.13)
Total fixed cost	47.13 (18.00)	40.53 (16.01)	28.59 (11.40)	38.75 (15.13)
Gross cost	261.86 (100)	253.17 (100)	250.80 (100)	255.27 (100)
Value of dung	21.67	23.00	22.86	22.51
Net cost	240.19	230.17	228.44	232.93
Sale price of milk	39.17	40.84	40.58	40.19
Milk production (liter)	07.54	07.85	07.58	07.67
Value of milk	295.79	320.59	309.21	308.53
Gross return	317.46	343.59	332.07	330.14
Net return	55.60	90.42	81.27	75.76
No.of animals	9 3	5 3	08.00	154

Figures in parentheses indicate percentage to gross cost

Table - 5 : Cost of milk production for Milking buffalo (₹/liter)

Cost component	Land holding category			Overall
	Marginal	Small	Medium	
Green fodder	06.60 (19.09)	06.94 (21.60)	07.94 (24.14)	07.23 (21.61)
Dry fodder	09.06 (26.09)	08.57 (27.53)	09.06 (27.53)	08.89 (26.85)
Concentrate	05.50 (15.85)	04.90 (14.94)	05.23 (15.89)	05.20 (15.26)
Total feed cost	21.20 (61.03)	20.43 (73.93)	22.24 (67.60)	21.29 (67.52)
Family labour	06.56 (18.87)	05.97 (18.55)	06.01 (18.52)	06.18 (19.64)
Miscellaneous expenses	00.70 (02.00)	00.66 (00.02)	00.89 (00.02)	00.75 (00.68)
Total variable cost	28.87 (79.97)	27.08 (96.61)	29.16 (88.19)	28.22 (88.24)
Depreciation on fixed capital	02.88 (08.29)	02.64 (08.08)	02.46 (07.48)	02.66 (07.93)
Interest on fixed capital	03.36 (09.69)	02.51 (07.80)	01.28 (03.88)	02.38 (07.12)
Total fixed cost	06.25 (17.99)	05.16 (15.80)	03.75 (12.09)	05.05 (15.29)
Gross cost	34.72 (100)	32.25 (100)	32.91 (100)	33.28 (100)
Value of dung	02.87	02.92	03.00	02.93
Net cost	31.85	29.33	24.91	29.35
Sale price of milk	39.17	46.84	40.58	40.19
Net return	07.32	11.51	10.67	09.84

Figures in parentheses indicate percentage to gross cost

Cost and returns of milk production from buffaloes

Table 5&7 shows the cost and returns of milk production from buffaloes in Hardoi District of Uttar Pradesh. On an average, the gross maintenance cost for buffalo was worked out to be ₹ 255.27 and per day which varies from ₹ 261.86 and for marginal category to ₹250.80 for medium herd size category. The average gross maintenance cost per day per milch buffalo was found to be decreasing with increase in herd size category. Baweja (2004) also reported similar finding. The average total fixed cost was found to be ₹ 38.75 per buffalo per day which accounted for about 15.13 per cent share of gross cost which were in conformity with earlier studies (Prasad, 2010; Nagrale, 2011). On an average, the total variable cost per buffalo per day accounted for ₹ 216.51 Feed costconstituted major share in cost varying from 67.60 per cent for medium category to 61.07 per cent for marginal category. Overall labour cost was ₹ 47.41 per day and it was found that per buffalo per day labour cost decline from marginal (₹ 49.51) to medium category (₹ 45.80). The. share of feed cost in terms of percentage increased with the increase in herd size categories while the share of labour cost got marginally decreased with increase in herd size. Per day value of milk was

Table - 6 : Maintenance cost per cow per day (₹).

Cost component	Milking
Green fodder	54.81 (21.87)
Dry fodder	60.22 (24.03)
Concentrate	41.25 (16.46)
Total feed cost	156.14 (62.36)
Family labour	44.28 (17.67)
Miscellaneous expenses	05.33 (02.13)
Total variable cost	205.91 (82.16)
Depreciation on fixed capital	20.75 (08.28)
Interest on fixed capital	23.86 (09.56)
Total fixed cost	44.71 (17.84)
Gross cost	250.63 (100)
Value of dung	19.37
Net cost	231.36
Sale price of milk	38.56
Milk production (liter)	07.90
Value of milk	304.62
Gross return	323.99
Net return	73.66
Cost/liter of milk	32.75
No.of animals	8 1

Figures in parentheses indicate percentage to gross cost

found to be ₹ 295.79 for marginal category, ₹ 320.59 for small category and ₹ 309.21 for medium herd size category. Overall value of milk per day ₹ 330.14was worked out to be ₹ 29.36 per day. Per day value of milk production was decreased with increase in the herd size.

Nagrale (2011) and Venkatesh and Sangeeta (2011) reported similar finding which is in agreement with our findings. Net return per litre of milk was found to be positive for all the categories. It was highest for small category (₹ 90.42) and lowest for

Table - 7 : Cost of milk production for Milking cows (₹/liter)

Cost component	Milki ng
Green fodder	06.93 (21.84)
Dry fodder	07.62 (24.02)
Concentrate	05.22 (16.45)
Total feed cost	19.76 (62.29)
Family labour	05.60 (17.65)
Miscellaneous expenses	00.67 (02.11)
Total variable cost	26.06 (82.15)
Depreciation on fixed capital	02.62 (08.25)
Interest on fixed capital	03.03 (09.55)
Total fixed cost	05.65 (17.81)
Gross cost	31.72 (100)
Value of dung	02.45
Net cost	29.27
Sale price of milk	38.56
Net return	09.29

marginal category (₹ 55.60). It was observed that though the productivity of buffalo was not very high, it gave higher returns because of the fact that buffalo milk fetches a better price due to high fat content as compared to cow milk.

CONCLUSION

From the study it was concluded that the cost of milk production decreases with increase in herd size in case of buffalo and cow whether in case of in buffalo, cost of milk production low in marginal herd size category. The overall average milk yield per day of cows was highest per litre per animal followed by buffalo and least cows. To estimate economic feasibility of milk production in the area, the cost and returns were worked out for different species of milch animals based on per day milk production. It was concluded that, overall results of economic feasibility of milk production revealed that the highest returns from milk production per animal per day were in case buffaloes and cows. The evaluation of net maintenance cost was highest in case of cows followed by buffaloes. Feed and fodder cost accounted for about 64% of the total variable cost followed by labour cost 19%. The maintenance cost of milch buffalo per day was high and net return per day per milch buffalo was low due to low milk yield per day of milch buffalo. Value of milk production was estimated ₹ 308.53 and ₹304.62 respectively for buffaloand cow. The value of milk production in case of buffalo decreased with increase in herd size. Cost per litre of milk was found to be less for medium herd size category farmers. The share of feed cost in terms of percent of total cost increased with the increase in herd size category while the share of labour cost got marginally decreased with increase in herd size. Net return per milch animal from milk was found to increase with increase in herd size category in case of buffalo and cow net return was highest for medium herd size category. The overall average milk yield per day of buffaloes was found to be highest per animal per day followed by cows. The net return realized by overall average of buffaloes was found to be highest (₹75=76) followed by cows (₹ 73.66) per animal per day. It was observed through the productivity of buffaloes that it was very high; it gave higher return because of the fact that buffalo milk fetches a better price due to high fat content as compared to cow milk comprised of feeds, fodder, green fodder, concentratelabour wages, veterinary expenses, electricity charges and medicines etc., the fixed cost components include depreciation, interest on fixed capital. The proportion of variable cost and fixed cost in the total cost was 76.22 per cent and 23.78 per cent.The cost of production increased with increase in the size of dairy farm. It was highest for large farms (10,876) followed by medium farm (Rs.8838) and small farm (Rs.6, 932). The major components of variable cost were labour, which accounted for over 46 per cent of the total cost followed by cost of feeds, veterinary expenses and miscellaneous.

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2. Khalangre et al (2019) study examines various facets of dairy farming and the current state of milk production, consumption, and sales. The city of Latur was deliberately chosen for the investigation.
3. Kumari et al. (2020) conducted a study to find out the cost and return per litre of milk and concluded that about fifty per cent of total feed and fodder cost was incurred on concentrate and the cost incurred on feeding buffaloes was maximum followed by crossbred and local cows.
4. Agrawal et al. (2021). studied to find out profitability of milk production in Malwa and Kymore zones of Madhya Pradesh.
5. Dwivedi et al. (2024) estimated the milk production in the Ayodhya mandal of Uttar Pradesh for selected dairy breeds, Sahiwal, Murrah, and Crossbred (with jersey) during the years 2020-2021.
6. Singh (2007) conducted study on economics of milk production and marketed surplus in Imphal district of Manipur.
7. Bairwa (2004) conducted a study on production, consumption and marketed surplus of milk in the rural area of Tonk district (Rajasthan) and reported that 55 per cent of total milk produced was accounted as marketed surplus and it was disposed through different marketing channels viz., tea stall, milk producer's cooperative societies, halwai, milk vendors and private dairy.

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GROWTH PERFORMANCE, NUTRIENT DIGESTIBILITY FEEDING IN MURRAH BUFFALO HEIFERS UNDER DIFFERENT TREATMENTS

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ABSTRACT

Twenty-fourbuffalo (24) heifers of similar age and body weight were divided into 4 groups of 6 animals each. These animalswere feed wheat straw + concentrate, wheat straw + concentrate + berseem hay, wheat straw + concentrate + sorghum/ mustard green fodder, wheat straw + concentrate + oats silage in treatments T_1, T_2, $T_3$and T_4 respectively for a period of 90 days. The average body weight, body weight gain, body measurements, Dry Metter intake, feed: gain ratio, digestibility of nutrients, were similar in all the treatments groups. Feed cost per kg gain was least in group T_2 followed by T_3, T_4, and T_1. Therefore, incorporation of berseem hay in the conventional diets of buffalo heifer was found to be economical for buffalo heifers during feed scarcity periods.

Keywords: *Buffalo heifer, growth performance, digestibility, economics of feeding*

INTRODUCTION

Buffalo (*Bubalus bubalis*) is known as the world's second most important milch animal and this species contributes significantly to milk production in South Asia (Javaid *et al.,*2009). Buffalo has better digestive ability than cattle to utilize poor quality roughage (Agarwal *et al.,*2008). However, some problems like poor reproductive performance and low growth rate have been reported in buffaloes (Sahoo *et al.,* 2004;wynn *et al.,*2009). Balance nutrition and better management can enhance buffalo productivity. To have good dairy replacement stock and higher body weight gain in buffalo, an efficient calf feeding system is crucial. (Wynn *et al.,*2009)reported higher mortality and morbidity losses in buffalo calves which were attributed to poor feeding practices of calves.

Berseem and oats are grown during Rabi season while sorghum, maize, etc. are grown during summer. To achieve optimum growth rate in growing buffalo-calves, feed intake should be programmed in order to lower the concentrate ration in the diet to make feeding economical. This could be achieved by restricting concentrate with ad lib.Feeding of roughages. Therefore, the present study was undertaken to observe growth rate in buffalo heifers by feeding seasonal green fodder alone hay and silage with different levels of concentrate mixture and the economics of rearing of buffalo heifers under these feeding regimens.

MATERIALS AND METHODS

Twenty-four(24) Murrah buffalo heifers selected from Buffalo Dairy Farm Allahabad, Uttar Pradesh. The divided into fiveequal groups based on similar weight and age following completely randomized design. All the experimental buffalo heifers were feed as per the requirements (ranjhan,1998). The animals were feed wheat straw + concentrate + sorghum / mustard green fodder, wheat straw + concentrate + oats silage in treatments

T_1, T_2, T_3 and T_4 respectively. The experimental diets were iso- nitrogenous and iso-calori. The feeding schedule was modified as per monthly body weight changes. The concentrate mixture contained (% part: wheat 37, mustard cake 40, de- oiled rice polish 20, mineral mixture 2 and common salt 1).

Table - 1 : Proximate composition of feed ingredients (% DM basis)

Feed ingredient	DM	CP	EE	CF	NFE	Ash
Wheat straw	95.0	3.2	1.5	34.0	49.8	11.5
Berseem hay	85.0	14.7	1.6	30.6	41.0	12.1
Oat silage	25.0	10.4	2.5	20.8	56.3	10.0
Sorghum Fodder	35.0	7.8	1.7	32.3	49.6	8.6
Mustard green	33.0	9.6	1.8	31.1	56.1	6.4
Wheat grain	90.0	8.5	2.4	10.9	74.2	4.0
Mustard cake	90.0	29.2	5.0	8.3	50.2	7.3
De-oiled rice polish	89.0	11.6	1.2	14.1	61.3	11.8

Body weight and body measurements were taken at the beginning of the experiment and thereafter at monthly intervals. The feed intake was recorded fornightly for two consecutive days. Representative samples of berseem hay, oat silage, wheat straw, sorghum, mustard and concentrate mixture were taken daily for two consecutive days in each fortnight before feeding the animals for determining feed intake. Clean and fresh water was provided throughout the day.

Table - 2 : Body Weight, body weight gain and body measurement of buffalo heifers under different treatments.

Particular	Treatments			
	T_1	T_2	T_3	T_4
Body weight (kg)				
Total gain	31.oo±6.90	47.17± 11.34	35.32±5.67	28.00±15.77
Gain(g/d)	274.17±56.33	388.43±98.48	309.14±45.69	233.85±12.18
Body measurements (cm)				
Initial				
Body length	107.52±0.80	101.86±2.84	106.26±1.38	107.52±3.04
Body height	108.35±1.65	107.51±2.83	110.49±1.68	109.21±2.60
Chest girth	137.15±0.90	138.70±4.30	138.01±1.42	138.70±3.52
Abdominal girth	146.46±5.06	151.12±5.66	155.21±3.13	152.32±4.23
Final				
Body length	108.37±1.90	109.07±0.54	111.33±0.77	104.54±3.04
Body height	112.16±1.20	112.60±2.02	113.72±0.78	110.49±2.68
Chest girth	138.70±7.64	150.68±2.71	141.21±2.17	141.80±4.01
Abdominal girth	159.71±2.58	164.67±2.71	159.12±2.74	157.74±3.85

Cost of feeding per kg gain was also computed for different groups. Data were analyzed statistically (Snedecor and Cochran*,* 1994*)* using OPSTAT as per Sheoran(2004).

RESULTS AND DISCUSSION

The proximate composition of feeds has been given in Table 1. The different combinations of feeds did not have significant effects on average body weight gain and body measurements (Table.2). Though all the groups of buffalo heifers were feed as per there nutrient requirements but the average daily gain (388.44 g/d) was apparently higher in group (T_2) fed with berseem hay compared to T_1 (274.17 g/d), T_3 (309.14 g/d) and T_4 (233.85 g/d). The finding of the present study is in according with report of Sahu *et al.* (2006) and Ahmed *et al.* (2009). Blanco *et al.* (2010) also found non-significant differences in ADG of the animals fed Lucerne and Lucerne plus concentrate. Contrary to above findings, Kariuki *et al.* (1999) found higher ADG in legume fed cattle than to those feed non- leguminous fodder. There were no significant differences with regard to body length, body girth, chest girth and abdominal girth in different groups of buffalo heifers. Gupta *et al.* (1976)and Sejrsen and Larsen(1977) also reported that feeding of hay and silage alone or in combination with wheat straw or silage + concentrate or green fodder + concentrate had no significant effect on body length and height.

The feed intake and nutrient digestibility of buffalo heifers under different feeding management system have been presented in Table 3. The DM and water intake of growing buffalo heifers under different treatment was similar. Voluntary water intake was comparatively less in T_3 and T_4 as compared to T_1 and T_2 groups which might be due to more availability of succulent fodder in group T_3 and T_4 as compared to T_1 and T_2. The present results are in accordance with Bhatti *et al.* (2009*)* who reported that heifers feed green fodder require less voluntary water as compared to heifers raised on dry fodder and increase in DM intake is generally associated with increase in voluntary water intake in buffalo heifers. Wright (2007) also reported that average daily water intake was positively correlated with DMI and weight gain in addition to other factors.

The feed conversion ratio was similar in all the groups (Table 3). Although heifers fed with berseem hay required less feed per unit gain in body weight followed by T_1, T_3 and T_4. The present findings are in according with the findings of Nagpal*et al.* (1980) who reported that the ration comprising berseem and wheat straw exhibited higher efficiency of nutrient utilization during growth period in buffalo heifers as

Compared to the ration consisting of wheat straw + concentrate. Feed efficiency was better in buffalo heifers fed silage as roughage in diets as compared to feeding wheat straw and concentrate (Gupta *et al.*, 1976*;* Singh and Tripathi*,* 1983).Payne and Hancock*(1957)*reported that DMintake is influenced by quality and palatability of feed. Bhatti *et al.* (2008) mentioned that Lucerne was potentially selected by the ruminants because of its high palatability. The digestibility of DM, OM, CP, CF, EE and NFE was similar in all the treatments (Table 3). Chauhan *(1987)*and Karsli *et al.* (1999) reported that DM digestibility of berseem hay and oats silage with wheat straw as basal diet in buffalo heifers did not different significantly among the treatments. Venkateswarlu*et al.* (2012) also reported that the mean digestibility values of proximate principles in lambs fed concentrate or legume hay or maize silage rations were similar in seven different rations. The total feeding cost (Rs. /animal) for experimental heifers has been presented in Table 4. The feeding cost was lowest (Rs. 14514) for group T_4 fed on non-leguminous green fodder available at the time along

Table - 3 : Feed intake and nutrient digestibility in buffalo heifers under different treatments

Particular	Treatments			
	T_1	T_2	T_3	T_4
DM intake (kg/d)	3.38±0.002	3.29±0.030	3.47±0.002	3.27±0.003
DM intake (kg/100kg wt.)	2.16	2.15	2.21	2.23
Water intake (lit/d)	6.89±0.03	7.00±0.02	6.53±0.04	6.15±0.16
Feed: gain ratio	1:0.15	1:0.19	1:0.25	1:0.26
Nutrient digestibility (%)				
DM	58.3±1.1	61.2±0.8	60.5±1.2	59.4±0.4
OM	61.5±0.8	63.8±1.4	63.0±0.8	60.5±0.7
CP	63.8±1.2	64.0±1.5	63.5±0.9	63.8±1.1
CF	56.3±1.1	57.8±0.4	59.2±0.5	57.2±0.2
EE	59.1±0.2	58.7±1.1	60.7±1.4	55.2±0.3
NFE	64.7±1.2	66.3±0.5	63.4±0.2	62.9±1.0
NDF	51.2±0.5	53.5±0.3	54.8±1.0	52.3±1.2
ADF	47.1±0.7	48.1±0.5	47.0±1.2	46.4±0.6

with required amount of concentrate and wheat straw while it was highest (Rs.18801) for group T_1 fed on conventional concentrate mixture and wheat straw only.

Table - 4 : Feeding cost of buffalo heifers under different dietary treatments

Cost (Rs.)	Treatments			
	T_1	T_2	T_3	T_4
Cost of concentrate mixture (Rs.)	12369	7032	7012	7465
Cost of wheat straw (Rs.)	6432	5260	5562	4023
Cost of berseem hay[1] (Rs.)	--	3700	--	--
Cost of non- leguminous fodder (Rs.)	--	--	2084	--
Cost of oats silage1 (Rs.)	--	--	--	3028.54
Total cost (Rs.)	18,801	16,000	14,759	14,514
Daily feeding cost per heifer (Rs.)	25.25	21.49	19.80	19.48
Feed cost per kg gain (Rs.)	92.17	55.29	64.15	83.39

The total cost of feeding in treatment T1 was higher because heifers were feed more concentrate mixture to meet out the protein requirement which increased the cost of feeding. Sastry *et al.* (1988) also found that free choice of berseem either as hay or green was cheaper than concentrate or silage feeding for growth of buffalo heifers. Verma *et al*. (2010)and Medhi *et al.* (2010) also reported that feeding oat silage is economical than conventional feeding.

CONCLUSION

Incorporation of berseem hay in the

conventional diets of buffalo heifers was found to be economical without affecting feed intake and nutrient utilization.

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COLD PLASMA: REVOLUTIONIZING FOOD PRESERVATION FOR SAFETY AND FRESHNESS - A REVIEW

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ABSTRACT

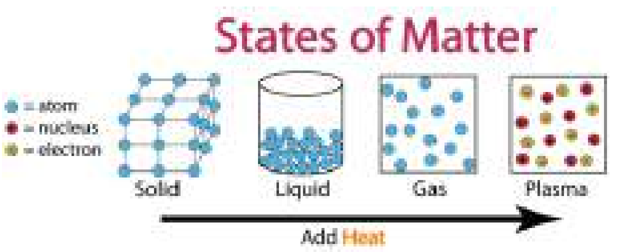
Cold plasma or non-thermal plasma is a unique state of matter characterized by partially ionized gases containing reactive species such as ions, electrons, and free radicals. In recent years, researchers have explored the applications of cold plasma in various industries with a particular focus and its efficacy in food preservation. Unlike traditional methods like heat treatment, cold plasma does not rely on elevated temperatures, making it a promising alternative for preserving the nutritional quality and sensory attributes of food products. Apart from this various antimicrobial effects has been demonstrated in a range of food products from fruits and vegetables to meats and seafood, highlighting the versatility of cold plasma in different food preservation applications.Moreover, cold plasma technology contributes to the reduction of chemical additives and preservatives in food processing. By effectively controlling microbial contamination, the need for synthetic preservatives is diminished, aligning with the growing consumer preference for clean-label and minimally processed foods.Recent advancements in cold plasma research have also explored its potential for extending the shelf life of perishable goods. The technology's ability to control enzymatic and oxidative reactions in food matrices contributes to the preservation of freshness and flavor, further enhancing the overall quality of preserved products. As a result, cold plasma has the potential to reduce food waste by minimizing spoilage and extending the distribution and storage periods of various food items.

Keywords : *Cold plasma, food preservation, microorganisms, food industry, sensory attributes.*

INTRODUCTION

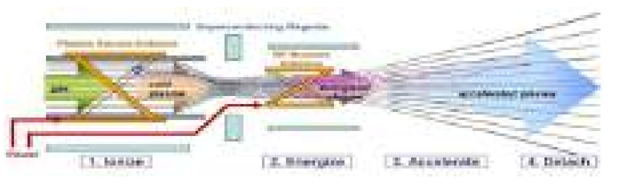
One could argue that plasma is the fourth state of matter. The theory behind the concept was that matter undergoes phase transitions, like the one from a solid to a liquid to a gas, by gradually receiving energy. The move from the gas state to the plasma state, even though it happens gradually as the system is given more and more energy, may be considered a further "phase transition." Consider plasma as a specific ionized gas that has some distinct characteristics that set it apart from a (perfect) gas. The state of ionized gas known as plasma is made up of free electrons, activated neutral species (excited and radical), and positively and negatively charged ions. These components are typically thermalplasmaand non-thermal or coldplasmabasedonthedifferenceincharacteristics (Sasai *et al*.,2009).

Thermal plasma has found its use in effectively treating the hazardous metal wastes (Pankaj *et al*., 2018; Mizuno*et al*., 2009). Non-thermal plasma are also called as cold plasma or non-equilibrium plasma is partially ionized gas which are produced under atmospheric/vacuum temperature of about 30- 60°C. Cold plasma contains various gaseous species possess same energy of above moderate room temperature but the electron poses higher temperature of 20,000K with higher energy (Misra *et al*., 2011).



Formation of Plasma:

Heating a gas can ionize its molecules or atoms, which decreases or increases the amount of electronsin them. This process transforms the gas into a plasma, which is made up of charged particles, such as negative and positive ions. Other methods, such as applying a strong electromagnetic field with a laser or microwave generator, can also cause ionization, which is followed, if present, by the breaking of molecular bonds. The plasma is electrically conductive due to the presence of a non-negligible number of charge carriers, which causes it to react strongly to electromagnetic fields. Thus, plasma is regarded as a different state of matter because of its characteristics, which are very different from those of solids, liquids, or gases.

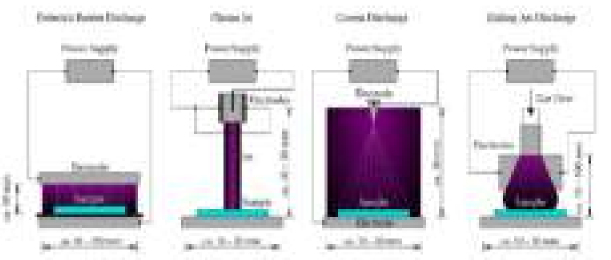


Generation ofPlasma

Plasma target chamber consist of simple gas such as air or nitrogen or the system with mixture of noble gases such as helium, argon and neon to attain plasma state. Ionized gas will be generated with the application of electric field or any external energy. For atmospheric cold plasma generation DBD method, atmospheric plasma jet discharge, corona discharge and gliding arc discharge are commonly used as it requires mild conditions for processing operation (Niemira, 2012; Mehmood *et al*., 2018).

Plasma generation systems that are widely used and are as follows:

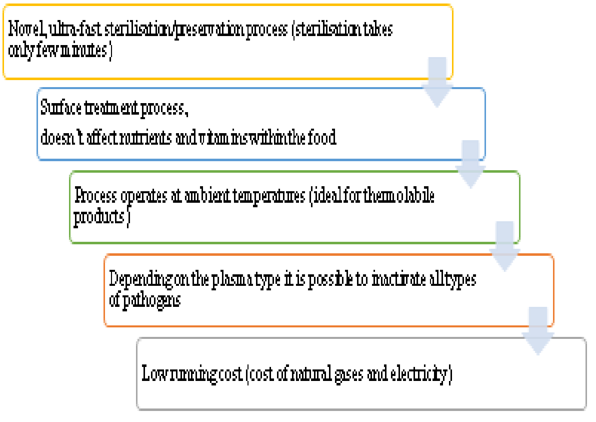
- Dielectric barrier discharge
- Jet discharge
- Gliding Arc discharge
- Corona Discharge plasma



Areas of Cold Plasma Technology in Food:

Cold plasma can be used for decontamination of products where micro-organisms areexternally located. Unlike light (e.g. ultraviolet light decontamination), plasma flows around objects, which means "shadow effects" do not occur ensuring all parts of a product are treated. For products such as cut vegetables and fresh meat, there is no mild surface decontamination technology available currently; cold plasma could be used for this purpose. Cold plasma could also be used to disinfect surfaces before packaging or included as part of the packaging process. Energy consumption would be similar to existing UV-C systems and the treatment of foodswouldbehighlycosteffective;theelectronicsandlifetimeofplasmatechnologiesarecomparable toUV-Csystemsevenwiththe additionalneedfora carriergas (Ir.ArietteMatser, http://www.novelq.org).

Advantages of Cold Plasmain Food Industry: (IndrekJogi, 2011)



Applications of Cold Plasma in Food Industry

Meat and Egg processing sector:

In meat sector, CP application was reported on beef, pork and chicken meat quality, microbial decontamination and shelf life extension. The result states that the cold plasma species are effective against E. coli, salmonella species, L.monocytogenes, yeast and mold species on meat surface (Rød *et al.*, 2012; Misra and Jo, 2017; Lee *et al.*,2011). CP decreases the immobilisation of water in protein myofibrillar network and changes its functional properties of packed meat. CP technology application is found to have positive effects on surface decontamination of egg shell membrane against S. enteritidis and S. typhimurium microorganism (Ragni *et al.*,2010). Atmospheric plasma jets were checked on the surface of sliced ham and chicken meat. The result showed a significant log reduction of 6.52 when treated with nitrogen and oxygen mixture type (Song *et al.*, 2009). Thus CP helps in achieving the better quality meat products in the market.

Fruits and vegetable processing sector (Fruits &Vegetables):

Cold plasma treatment is said to be an ingenious technique since its replaces chlorine and water for decontamination of several fruits and vegetables. Cold plasma treatments on fruits and vegetable products includes berries, cherries, Apple, melon, Kiwi etc. were studied. Results proclaimed that CP treatments on the surface of F &V (Fruits & Vegetables) alters the pH and acidity of the food produce. This changes occurs when active species of plasma reacts with moisture on the surface. It is also found that the treated produce shows slight changes in texture (firmness) and colour during their storage period plasma (https://fstjournal.org/ features/28-1/cold-4431-plasma, 2019).

Cold plasma in food packaging :

Originally cold plasma technology was employed for improving the surface modification and printability for packaging materials. Currently, CP treatments are utilised for the food packaging and biofilms treatments to enhance its antimicrobial and mechanical properties. Fresh food products after harvest are still biologically active with active mass and energytransport systems. Fruits,in general, are covered with a biopolyester called cutin, which isembedded in a natural wax that serves as the major barrier to moisture loss. The wax layerthatcovers the surface of applesisapplied to protect thefruitfrom stressfactors such asmoistureloss (produced by transpiration of the fruit), mechanical damage, oxidation, and microbial infections. Nowadays, thin-film deposition by plasma processing technique has madecontributions in the medicine, biology, environmental science, food science, and semiconductor industries. The application of this technology has become increasingly important in recent years. The cold atmospheric-pressure plasma zone was obtained by increasing the voltage applied to a needle-to-needle configuration until the electric field intensity in the feedmaterial (argon + monomer) was sufficiently high to result in electron avalanches and streamers.It was useful to predict the voltage at which there is a transition from electron avalanches to self-propagating streamers. This is defined as the corona onset criterion (Anato *et al*.,2009). In these experiments,argon was picked as the carrier gas. The food material (apple) was placed in a treatment chamber located downstream from the activation zone in the Atmospheric Pressure Cold Plasma Reactor(APCPR).Vanillinwaspicked as the monomer because of its wide use in the food industry and its capacity to form plasma-polymerized films. After the film was deposited on the apple surface, further analysis like Environmental scanning electron microscopy (ESEM) and Fourier transforminfrared (FTIR) studies were conducted.

CONCLUSION

In conclusion, cold plasma technology stands at the forefront of a paradigm shift in food preservation, offering a non-thermal and environmentally friendly approach to enhance safety and freshness. The antimicrobial properties, minimal impact on nutritional quality, and potential for reducing chemical additives position cold plasma as a promising technology for the future of food preservation. Researchers and industry professionals alike are actively exploring and developing applications for cold plasma, making significant strides toward a more sustainable and efficient food preservation landscape.

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AGRICULTURAL LABOUR IN ECONOMICS

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ABSTRACT

Agricultural labour plays a pivotal role in the economy, particularly in agrarian societies and developing countries where agriculture is a significant sector. These labourers engage in various tasks essential for crop cultivation, livestock management, and other agricultural activities. Their roles range from planting and harvesting crops to tending to animals and maintaining agricultural infrastructure. In economics, the study of agricultural labour encompasses several critical aspects. It examines the dynamics of labour supply and demand in rural areas, considering factors such as seasonal fluctuations, technological advancements, and demographic changes. Additionally, economists analyze the impact of agricultural labour on overall productivity, income distribution, and rural development. Overall, understanding the economics of agricultural labour is crucial for policymakers, researchers, and stakeholders seeking to enhance agricultural sustainability, reduce poverty, and foster inclusive economic growth in rural communities.

Keywords : *Agriculture, sustainability, labour, economy.*

INTRODUCTION

Agricultural labor refers to the physical or intellectual work performed by individuals directly involved in the cultivation, production, and management of crops, livestock, and other agricultural activities. This encompasses a broad spectrum of tasks, including planting, harvesting, tending to animals, operating machinery, managing farm operations, and engaging in related activities such as irrigation and pest control. Agricultural labor is essential for the functioning of the agricultural sector and plays a critical role in food production, rural livelihoods, and economic development.

The definition of agricultural labour is given by the Agriculture Labor Enquiry Committee. Agricultural labourers are those people who derive their source of income mainly by working on farms and lands of other people. They work for the wages. .The agricultural labour enables the backward and other low classes of people to come to the level of other people. The people work for their living.

Importance of agriculture labour

Agricultural labour is the backbone of global food production, playing a pivotal role in ensuring food security, sustaining rural livelihoods, and driving economic development. From planting and harvesting crops to tending to livestock and managing agricultural operations, the efforts of millions of agricultural laborers worldwide are essential for meeting the growing demand for food in an increasingly populated world. The importance of agricultural labour extends beyond its direct contribution to food production. It supports rural economies, providing employment opportunities and income stability for millions of individuals and families in rural communities. Additionally, agricultural labour contributes to economic growth through its role in agribusinesses, supply chain activities, and trade in agricultural commodities. Furthermore, agricultural labour plays a crucial role in promoting environmental sustainability by implementing conservation practices, managing natural resources responsibly, and fostering resilience to climate change. The knowledge, skills, and innovations of agricultural laborers are instrumental in adapting farming systems to evolving environmental challenges and ensuring the long-term viability of agriculture. Agricultural labour is indispensable for addressing global challenges such as hunger, poverty, and environmental degradation. Recognizing and supporting the importance of agricultural labour is essential for achieving sustainable development goals and building a more resilient and equitable food system for future generations.

Types of gricultural Labour

In India, agricultural laborers can be broadly categorized into various types based on their roles, skills, and socio-economic characteristics. Some of the main types of agricultural laborers in India include:

Landless Laborers: These are individuals or families who do not own land and work as hired labor on farms owned by others. They typically perform tasks such as planting, weeding, harvesting, and other manual labor activities in exchange for wages.

Smallholder Farmers: Smallholder farmers own or lease small plots of land and engage in subsistence or small-scale commercial farming. They often rely on family labor for agricultural activities but may also hire additional labor during peak seasons.

Tenant Farmers: Tenant farmers rent land from landowners and cultivate crops or raise livestock on the rented land. They may provide their labor or hire agricultural laborers to work on the leased farms.

Migrant Laborers: Migrant agricultural laborers move seasonally or temporarily from one region to another in search of employment opportunities in agriculture. They often travel long distances to work on farms during peak agricultural seasons and return to their home regions during the off-season.

Skilled Workers: Skilled agricultural laborers possess specialized skills and knowledge in areas such as animal husbandry, crop management, irrigation, and machinery operation. They play crucial roles in implementing modern agricultural techniques and technologies on farms.

Unskilled Workers: Unskilled agricultural laborers typically perform manual tasks that require minimal training or expertise, such as carrying loads, clearing land, or basic fieldwork. They form a significant portion of the agricultural workforce in India.

Women and Children: Women and children often contribute to agricultural labor in India, particularly in activities such as transplanting, weeding, and harvesting. Their participation in agricultural work varies depending on cultural norms, household dynamics, and socio-economic factors.

Difference between agricultural labour and cultivator

Agricultural labour

- Agricultural laborers are individuals who provide labor for various tasks in agriculture but do not own or directly control the land they work on.
- They typically work as hired hands, performing manual tasks such as planting,

weeding, harvesting, and other farm activities.

- Agricultural laborers are often employed by landowners, tenant farmers, or agribusinesses and receive wages or other forms of compensation for their work.
- They may work seasonally or year-round, depending on the agricultural cycle and demand for labor.

Cultivator

- A cultivator, also known as a farmer, is an individual who owns or controls land and is directly engaged in agricultural production.
- Cultivators are responsible for planning, managing, and carrying out farming activities on their land, including cultivation of crops, raising livestock, and maintaining agricultural infrastructure.
- Unlike agricultural laborers, cultivators have a stake in the land they cultivate and typically make decisions regarding crop selection, farming methods, and investment in agricultural inputs.
- Cultivators may work independently as smallholder farmers or as part of larger farming operations, and they may rely on their own labour, family labour, or hired labour to carry out farming activities.

The main **features** of agricultural labour in India are influenced by a combination of socio-economic, cultural, and structural factors. Some of the key features include:

Large Workforce: India has a significant agricultural labour force, with millions of people engaged in agricultural activities across the country. Agriculture remains a primary source of employment, particularly in rural areas where a substantial portion of the population relies on agriculture for livelihoods.

Seasonal Employment: Agricultural labour in India is often characterized by seasonal employment patterns, with peak demand for labour during planting and harvesting seasons. Many agricultural laborers work seasonally, moving between regions to find employment opportunities during peak agricultural activities.

Fragmented Land Holdings: The prevalence of small and fragmented land holdings in India has led to a reliance on labor-intensive farming practices. Smallholder farmers often lack access to mechanized equipment and rely on manual labour for various agricultural tasks.

Low Wages and Informal Employment: Agricultural labour in India is often characterized by low wages and informal employment arrangements. Many agricultural laborers work under informal contracts, without access to social security benefits or legal protections.

Gender Dynamics: Women play a significant role in agricultural labour in India, particularly in activities such as planting, weeding, and harvesting. However, women often face disparities in wages, access to resources, and land ownership rights compared to male counterparts.

Migration: Seasonal migration for agricultural work is common in India, with laborers moving from rural to urban areas or across regions in search of employment opportunities. Migrant agricultural laborers often face challenges such as poor working conditions, exploitation, and lack of social protection.

Vulnerability to Shocks: Agricultural laborers in India are vulnerable to various shocks and risks, including fluctuations in agricultural prices, natural disasters, and climate change impacts. These vulnerabilities can have significant implications for livelihoods and food security among rural communities.

Dependency on Traditional Practices: Despite efforts to modernize agriculture, traditional farming practices and manual labour continue to dominate in many parts of India. Limited access to technology, capital, and infrastructure often restricts the adoption of mechanized farming methods.

Social Hierarchies: Caste-based social hierarchies influence the distribution of agricultural labour in India, with marginalized communities often relegated to low-paying and menial agricultural tasks. Addressing caste-based discrimination is essential for promoting social equity and inclusion in the agricultural sector.

Policy Interventions: Government policies and programs aimed at improving agricultural productivity, enhancing rural livelihoods, and promoting social welfare play a crucial role in shaping the conditions of agricultural labour in India. However, challenges such as implementation gaps, inadequate enforcement, and limited access to resources remain prevalent.

Agricultural wages and income

In India, the agricultural wages are very low. The first agricultural Labour Enquiry Committee in its report mentioned that the per capita annual income of agricultural labour families was as poor as Rs. 104 in 1950-51 and the annual average income of household was Rs. 447. After the introduction of improved farming methods and mechanization of the level of income of farmers increased the average all India daily wage rate for Agricultural Labourers has increased from Rs 292.05 in 2019-20 to Rs 328.18 in 2021-22.

Measures adopted by the government to improve the condition of farm worker

Here are some common measures implemented by governments:

Minimum Wage Laws: Governments establish and enforce minimum wage laws to ensure that farm workers receive fair compensation for their labour. Minimum wage regulations help protect workers from exploitation and ensure a decent standard of living.

Employment Guarantee Schemes: Governments implement employment guarantee schemes to provide rural farm workers with guaranteed employment opportunities, especially during lean agricultural seasons. Programs such as the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) in India offer employment to rural households for a minimum number of days per year, thereby enhancing income security.

Social Security Programs: Governments provide social security programs such as health insurance, pension schemes, and accident insurance to farm workers. These programs help mitigate risks associated with agricultural work, provide access to healthcare services, and ensure financial stability during emergencies or retirement.

Skill Development Initiatives: Governments invest in skill development programs to enhance the employability and productivity of farm workers. Training initiatives focus on improving agricultural techniques, machinery operation, livestock management, and other relevant skills to increase efficiency and income levels.

Access to Land and Resources: Governments promote land reforms and land redistribution policies to provide landless farm workers with access to agricultural land. Land allocation programs, land leasing regulations, and land tenure security measures enable farm workers to engage in farming activities independently and improve their economic status.

Credit and Financial Support: Governments offer credit facilities, subsidies, and financial assistance programs to farm workers to facilitate agricultural activities. Access to affordable credit enables farm workers to invest in inputs such as seeds, fertilizers, equipment, and irrigation infrastructure, thereby enhancing productivity and income levels.

Housing and Infrastructure Development: Governments invest in rural housing and infrastructure development to improve living conditions and amenities for farm workers. Construction of affordable housing, provision of clean water supply, electrification, and road connectivity initiatives contribute to better quality of life and attract skilled labour to rural areas.

Research and Extension Services: Governments support agricultural research and extension services to disseminate best practices, technologies, and innovations to farm workers. Extension programs provide training, advisory services, and access to agricultural information, empowering farm workers to adopt modern farming techniques and improve productivity.

Suggestions for improving the condition of agricultural labour

- Strengthen enforcement mechanisms to ensure compliance with minimum wage laws in the agricultural sector, providing farm workers with fair compensation for their labor.
- Scale up employment guarantee schemes like MGNREGA to provide rural farm workers with more opportunities for dignified and secure employment during lean agricultural seasons.
- Implement land reforms to provide landless farm workers with access to agricultural land, promoting land redistribution, land leasing regulations, and tenure security measures.
- Improve access to affordable credit and financial services for farm workers, enabling them to invest in agricultural inputs, equipment, and infrastructure to enhance productivity and income levels
- Invest in rural housing and infrastructure development to improve living conditions and amenities for farm workers, including access to clean water, sanitation, electricity, and transportation
- Invest in skill development programs to enhance the employability and productivity of farm workers, providing training in modern agricultural techniques, machinery operation, and livestock management.

CONCLUSION

Agricultural labour in India remains a cornerstone of rural livelihoods, food security, and economic development. Despite its significance, agricultural laborers often face numerous challenges, including low wages, informal employment, inadequate social protections, and limited access to resources. Addressing these challenges requires concerted efforts from policymakers, stakeholders, and civil society to improve the condition of agricultural laborers and promote inclusive rural development. By enforcing minimum wage laws, expanding social security coverage, promoting land reform, facilitating access to credit and skill development, and investing in housing and infrastructure, India can enhance the well-being and empowerment of agricultural laborers. Additionally, strengthening legal protections, promoting collective bargaining, improving access to education and healthcare, and supporting research and extension services are essential for ensuring the dignity, rights, and socio-economic advancement of agricultural laborers. Through collaborative efforts and targeted interventions, India can harness the potential of its agricultural workforce to drive sustainable agricultural growth, reduce rural poverty, and build resilient rural communities for the future.

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