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Effect of Organic and Inorganic Fertilizers on Pest Incidence and Yield of Okra under Integrated Nutrient Management

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A B S T R A C T

A field experiment on "Effect of INM on growth, yield and quality of Okra [*Abelmoschus esculentus* (L.) Moench]" was conducted at the instructional farm of Krishi Vigyan Kendra Jajpur situated at Badachana. The experiment was conducted to find out the best suited integrated nutrient management practices for reducing incidence of disease and pest. The experiment was laid out in randomized block design (RBD) with three replications and twelve treatments. From the experiment it was observed that treatment T_7 [RDF (75%) + (25%) neem oil cake], has significant effect on disease incidence and pest population by reducing. Incidence of YVMV from 30.87% to 18.01%, jassid population from 7.23 to 2.68 per three leaves, mite population from 6.72 to3.25 per three leaves, white fly population from 8.84 to 2.42 per three leaves and shoot and fruit borer from 14.45% to 4.37%. Maximum fruit yield per plant 202.16 g was recorded in T_7 fruit yield per hectare varied significantly and was maximum with T_7 (103.90q) and was minimum with T_{12} (51.63 q). T_7 (103.90 q) and T_5 (98.25 q) were at par with each other. Combined use of 75 % RDF as inorganic fertilizer with 25 % RDF through neem oil cake (T_7) recorded highest gross income of Rs.1,24,680, net income Rs.78,020 per hectare, and maximum benefit cost ratio 2.67.

Introduction

Okra, (*Abelmoschus esculentus* (L). Moench) belonging to family Malvaceae (2n= 130) commonly known as Bhindi, Gumbo and Lady's finger is a popular fruit vegetable grown round the year and fetches premium price in the market. The major diseases and pests of okra are yellow Vein Mosaic Virus (YVMV) transmitted by white fly (*Bemisia tabaci* Genn.), jassid, mite, fruit borer (*Earias vittella* Fabr) causing extensive damage to okra fruits and cause loss in marketable fruit yield. Unjudicious use of chemical fertilizers increased the incidence of pests and diseases. Therefore, it is felt necessary to reduce the environmental risk as well as human health hazards by reducing the levels of inorganic fertilizers level with adoption of suitable combinations of organic and inorganic fertilizers under integrated nutrient management system. Hence, the present experiments were conducted to study the effect of integrated nutrient management system on incidence of major pests, yield and economics of okra.

Materials and Methods

A field experiment was conducted at the instructional farm of Krishi Vigyan Kendra Jajpur situated at Badachana which is 65 km. away from Odisha University of Agriculture and Technology, Bhubaneswar during 2015. The experiment was conducted to study the effect of integrated nutrient management practices on incidence of pests and yield of okra var. Pusa A4. The experiment was laid out in randomized block design (RBD) with three replications and twelve treatments. The Treatments involed were T_1 (100% RDF), T_2 [100 % RDF + FYM (15 t/ ha)], T_3 [RDF (75%) + Azotobacter + Azospirillum + PSB (2kg/ha)], T_4 [RDF (75%) + (25%) FYM], T_5 [RDF (75%) + (25%) vermicompost], T_6 [RDF (75%) + (25%) poultry manure], T_7 [RDF (75%) + (25%) neemoilcake], T_8 [RDF (50%) + (25%) FYM + (25%) vermicompost], T_9 [RDF (50%) + (25%) FYM + (25%) poultry manure], T_{10} [RDF (50%) + (25%) FYM + (25%) neem oil cake], T_{11} [(25%) FYM + (25%) vermicompost + (25%) poultry manure + (25%) neem oil cake], T_{12} [(25%) FYM + (25%) vermicompost + (25%) poultry manure + (25%) neem oil cake + sea weed extract (15kg/ha)], where RDF is recommened dose of fertilizers (80:40:40 NPK kg/ha.). Organic manures were applied one week before sowing. Full dose of phosphorus, potassium and half dose of nitrogen as per treatments were applied just before sowing. The remaining half dose of nitrogen was applied 30 days after sowing. All cultural practices were followed regularly during crop growth. Jassids, white flies, mites counts were made on three leaves (top, middle and bottom) per plant of five randomly selected plants of each plot. The insects population was recorded at 20, 30, 40 and 50 days after sowing (DAS). Observations on incidence of YVMV were recorded at 15 days interval starting from 20th DAS to final harvesting of fruits. The fruits harvested at each picking in the individual plots were counted for bored and healthy fruits and their weights recorded separately and percent infestation was worked out. The data on these parameters were subjected to statistical analysis to draw logical conclusions.

Results and Discussion

Significantly lower population of jassids (2.68 nymphs per three leaves per plant) was recorded in the treatment (T_7) where 75 % of RDF through inorganic fertilizer and 25 % through neem oil cake were applied. However, it was at par with the treatment T_{10} (2.92 nymphs per three leaves per plant) where RDF (50 %) + 25 % FYM + 25 % neem oil cake were applied and in T_5 (3.24 nymphs per three leaves per plant) where, 75 % RDF through chemical fertilizers + 25 % vermicompost were applied. Highest population was observed in T_1 (7.23 nymphs per three leaves per plant) where only chemical fertilizer was applied (100% RDF). The present findings corroborate with the findings of Kavitharaghavan *et al.*, (2005) who reported that soil application of FYM (12.5 t/ha) followed by neem cake (1000 kg/ha) in 3 split was found consistently effective in reducing the incidence of jassid. However, Mandal *et al.*, (2006) reported that soil application of neem cake 200 kg ha^{-1} along with three foliar sprays of endosulphan 35 EC @ 0.5 mg ha^{-1} after 20, 40, 60 days of crop emergence reduced jassid population 6.8 per 30 leaves.

Application of 75 % RDF through inorganic fertilizer + 25 % through neem oil cake fertilizer significantly reduced the white fly population to 2.42 white fly per three leaves per plant. This was at par with T_{10} (1.80) where 50 % RDF + 25 % FYM + 25 % neem oil cake were applied. However, maximum of 8.84 whitefly population (8.84 per three

leaves per plant) was recorded in the treatment T_1 (100% RDF). Similar type of result were also reported by Joshi (2011) that application of 75 % RDN through neem oil cake + 25 % through chemical fertilizer lowered white fly population (2.23 white fly per three leaves per plant). This was also reported at par with treatment where 75 % RDN through poultry manure + 25 % chemical fertilizer were applied (2.61 white fly per three leaves per plant). Adilakshmi *et al.,* (2008) recorded that application of 75 % RDF from neem oil cake and 25 % RDF from chemical fertilizers significantly lowered white files population 2.37 per three leaves per plant.

Mite population was found to be minimum in T_7 (3.25 mites per three leaves per plant) receiving 75 % RDF through inorganic fertilizer and 25 % through neem oil cake. It was found to be at par with T_{10} (3.98 mite per three leaves per plant) where, 50 % RDF through chemical fertilizer + 25 % through FYM + 25 % through neem oil cake were applied, T_5 (4.06 mite per three leaves per plant) where 75 % RDF + 25 % vermicompost were applied and T_{11} (3.67 mite per three leaves per plant) where 25 % FYM + 25 % vermicompost + 25 % poultry manure + 25 % neem oil cake were applied. Whereas, maximum mite population was recorded in T_1 (6.72 per three leaves per plant) (Table 1).

Similar type of results were reported by Joshi (2011) where, application of 75 % RDN through neem oil cake + 25 % through chemical fertilizer significantly lowered population of mite (1.14 mite per three leaves per plant) and it was found at par with treatment where 75 % of RDN were applied through poultry manure and 25 % through chemical fertilizer (1.45 mites per 3 leaves per plant) and 75 % of RDN applied through vermicompost and 25 % through chemical fertilizer (1.72 mites per three leaves per plant). Similar observations were also reported by Mahto and Yadav (2009).

Significantly lower fruit infestation (4.87 %) was found in treatment T_7 where 75 % RDF through chemical fertilizer + 25 % through neem oil cake were applied. whereas, highest fruit infestation (14.45 %) was occurred in $T_1$where only chemical fertilizers were applied. All other treatments differed significantly so far as fruit and shoot borer infestation was concerned. Similar type of result was also reported by Adilaxmi *et al.,* (2008) who found that minimum shoot and fruit borer damage percentage (2.37 %) was observed in the field receiving treatment 75 % RDF from neem oil cake and 25 % RDF from chemical fertilizer. Minimum fruit infestation (2.43 %) due to fruit borer in okra was also reported by Joshi (2011) in which 75 % RDN was supplied through neem oil cake and 25 % through chemical fertilizer. However, it was at par with the treatment where 75 % RDN through poultry manure combined with 25 % through chemical fertilizer were applied (3.03 %).

Considering the disease intensity of yellow vein mosaic in the present experimental trial, the treatment (T_7) where 75 % RDF applied through chemical and 25 % through neem oil cake recorded significantly minimum disease intensity (18.01 %). This was at par with T_{11} (26.25 %) where 25 % FYM + 25 % vermicompost + 25 % poultry manure + 25 % neem oil cake were applied. Maximum yellow vein mosaic virus infestation was recorded in T_1 (30.87 %). The present findings corroborate with the findings of Tripathy *et al.,* (2008) in which application of reduced level of 50 % RDF @ 150:100:80 kg ha^{-1} + biofertilizer + organic manure in the form of neem cake (both @ 1.25 and 2.5 t ha^{-1} or vermicompost @ 2.5 t/ha significantly reduced YVMV infestation in okra. However,

Joshi (2011) observed that application of 75 % RDN through neem oil cake and 25 % through chemical fertilizer significantly reduced disease intensity (15.02 %). Also Adilakshmi *et al.,* (2008) has reported the effectiveness of neem oil cake against the yellow vein mosaic vector on okra. This might have attributed due to presence of triterpenoids in neem cake, which has insecticidal property (Godase and Patel, 2003). The better efficiency of neem cake might be due to the presence of "Azadirachtin" associated with nimbin, nimbidin, salonine etc, which have multifarious activities such as insect repellant, feeding oviposition deterrent, growth regulatory effect, direct toxicity etc. (Plant Horticulture Technology, 2002).

Effect of INM on yield

In the present study fruit yield per plant (202.26g) and fruit yield per ha. (103.90q) was found to be maximum with T_7 receiving 75 % RDF + 25 % neem oil cake which was at par with (T_5) 75 % RDF + 25 % vermicompost which recorded yield of (190.96 g per plant) and (98.25 q per ha) respectively.

Increase in yield might be due to combined application of inorganic fertilizers and organic fertilizers through neem oil cake proved to be very significant in reducing incidence of diseases and pests. The efficacy of neem cake in reducing incidence of pest in okra was reported by Godase and Patel (2001), Mallick and Lal, (1989) and Tripathy *et al.,* 2009). Again application of neem oil cake along with chemical fertilizer significantly increased the number of fruits per plant, fruit weight which resulted in increasing yield. Application of neem cake increased N uptake by reducing urea hydrolysis, ammonia volatilization losses, leaching losses and decrease CO_2 evolution (Plant Horticulture Technology, 2002). Thus, neem cake application, as a whole might have increased allocation of photosynthates in the plant system, which might have resulted in higher number of fruits per plant and fruit weight in okra.

The present results corroborate with the findings of Kurup *et al.,* (1997). The neem cake apart from improving the soil condition, also built up favourable C/N ratio with appreciably higher content of nutrients (Dahama, 2003) and their ready availability due to its slow release for a prolonged period could be possible reasons for influence on green fruit yield in okra. These findings corroborate with the findings of Sanigrahi and Borah(2001), Tripathy *et al.,* (2008), Yadav and Yadav, (2010), Akande *et al.,* (2010), Bairwa *et al.,* (2009), Prasad and Naik (2013), Mal *et al.,* (2014), Choudhary *et al.,* (2015), Das *et al.,* (2014), Anand *et al.,* (2016), Kumar *et al.,* (2017) in okra.

Effect of INM on economics of okra

The total cost of cultivation in okra varied from Rs.36, 535 to Rs.46, 660 ha^{-1}. Maximum cost of Rs.46, 660 was incurred in T_7 where 75 % RDF + 25 % neem oil cake were applied. Whereas, minimum cost of Rs.36, 585 ha^{-1} incurred in T_{12} where only organic manures with sea weed extract were applied. Highest gross income of Rs.1, 24, 680 was obtained in treatment T_7. Whereas, lowest of Rs.61, 956 was obtained in T_{12} where only organic manures were applied with sea weed extract. Similarly highest net return of Rs.78, 020 was obtained in T_7 where 75 % RDF + 25 % neem oil cake were applied and was followed by T_5 where 75 % RDF + 25 % vermicompost were applied. Whereas, lowest of Rs.25, 431 was obtained in T_{12} where only organic manures were applied with sea weed extract. This might be due to that application of 75 % RDF + 25% neem oil cake or vermicompost recorded significantly higher

yield, which resulted in higher economic return. Highest B:C ratio (2.67) was observed in T_7 with integrated use of 75 % RDF + 25 % neem oil cake followed by T_5 (2.57) where 75 % RDF + 25 % vermicompost were applied. The lowest B:C ratio of 1.69 was observed in T_{12} where 25 % FYM + 25 % vermicompost + 25 % poultry manure + 25 % Neem oil cake + sea weed extract(15kg/ha) were applied. The increase in B:C ratio and other crop growth parameters might be due to increase in yield which fetched more prices in market. These findings corroborate with the findings of Kumar *et al.,* (2013), Mal *et al.,* (2014) and Tyagi *et al.,* (2016) (Table 2).

Table.1 Pest population as influenced by integrated nutrient management in okra

Treatments		*Jassid (no.)	*Whitefly(no.)	*Mite(no.)	**Shoot and fruit borer (%)	**YVMV (%)
T_1	100% RDF	**7.23 (2.78)**	**8.84 (3.06)**	**6.72 (2.69)**	**14.45 (22.34)**	**30.87 (33.75)**
T_2	100% RDF + FYM (15 t / ha)	5.63 (2.48)	5.26 (2.40)	5.40 (2.43)	13.25 (21.35)	25.48 (30.32)
T_3	RDF (75%) + *Azotobacter* + *Azospirillum* + PSB (2kg/ha.)	4.68 (2.28)	7.54 (2.84)	5.67 (2.48)	14.10 (22.06)	24.56 (29.71)
T_4	RDF (75%)+(25%)FYM	5.42 (2.43)	6.82 (2.71)	5.10 (2.37)	12.23 (20.47)	26.23 (30.81)
T_5	RDF (75%)+(25%) VC	3.24 (1.93)	3.02 (1.88)	4.06 (2.14)	13.87 (21.87)	21.67 (27.74)
T_6	RDF (75%)+(25%) PM	4.89 (2.32)	5.91 (2.53)	4.95 (2.33)	11.57 (19.89)	24.46 (29.64)
T_7	RDF (75%) + (25%) NOC	**2.68 (1.78)**	**2.42 (1.71)**	**3.25 (1.94)**	**4.37 (12.07)**	**18.01 (25.11)**
T_8	RDF (50%) + (25%) FYM+ (25%) VC	4.82 (2.31)	4.08 (2.14)	4.84 (2.31)	12.57 (20.77)	22.86 (28.56)
T_9	RDF (50%) + (25%) FYM+ (25%) PM	4.98 (2.34)	5.82 (2.51)	4.97 (2.34)	13.46 (21.52)	23.75 (29.17)
T_{10}	RDF (50%) + (25%) FYM + (25%) NOC	2.92 (1.85)	2.73 (1.80)	3.98 (2.12)	6.57 (14.85)	22.56 (28.36)
T_{11}	25% FYM + (25%) VC + (25%) PM + (25%) NOC	4.24 (2.18)	3.26 (1.94)	3.67 (2.04)	6.37 (14.62)	19.56 (26.25)
T_{12}	25 % FYM + (25%) VC + (25%) PM + (25%)NOC+ SWE(15kg/ha)	3.82 (2.08)	4.74 (2.29)	5.56 (2.46)	10.54 (18.94)	25.53 (30.35)
SE(m+)		0.06	0.05	0.07	0.07	0.51
CD		0.19	0.14	0.21	0.21	1.48

* Figures in parentheses indicate the corresponding square root transformed values
** Figures in parentheses indicate the corresponding Angular transformed values
FYM - Farm yard manure, VC - Vermicompost, PM - poultry manure, NOC - Neem oil cake, SWE – Sea weed extract

Table.2 Effect of INM on economics of okra

Treatments		Yield Per plant (g)	Yield Per ha (qtl)	Cost of cultivation (Rs)	Gross income (Rs)	Net income (Rs)	B:C ratio
T_1	100% RDF	165.12	84.87	43,200	1,01,844	58,644	2.35
T_2	100% RDF + FYM (15 t / ha)	170.30	87.60	45,160	1,05120	59,960	2.32
T_3	RDF (75%) + *Azotobacter* + *Azospirillum* + PSB (2kg/ha.)	137.55	67.06	38,450	80,472	42,022	2.09
T_4	RDF (75%)+(25%)FYM	140.79	70.34	41,716	84,408	42,692	2.02
T_5	RDF (75%)+(25%) VC	190.96	98.25	45,762	1,17,900	72,138	2.57
T_6	RDF (75%)+(25%) PM	151.10	77.72	44,925	93,264	48,339	2.07
T_7	RDF (75%) + (25%) NOC	202.16	103.90	46,660	1,24,680	78,020	2.67
T_8	RDF (50%) + (25%) FYM+ (25%) VC	160.98	82.75	44,782	99,300	54,518	2.21
T_9	RDF (50%) + (25%) FYM+ (25%) PM	150.04	77.16	41,395	92,592	51,197	2.23
T_{10}	RDF (50%) + (25%) FYM + (25%) NOC	177.52	91.30	44,650	1,09,560	64,910	2.45
T_{11}	25% FYM + (25%) VC + (25%) PM + (25%) NOC	130.39	59.28	37,520	71,136	33,616	1.89
T_{12}	25 % FYM + (25%) VC + (25%) PM + (25%) NOC +SWE(15kg/ha)	122.95	51.63	36,525	61,956	25,431	1.69
SE(m+)		6.57	3.42	-	-	-	-
CD		19.26	10.03	-	-	-	-

From the experimental result it was observed that integrated application of 75% RDF in the form of chemical fertilizers and 25 % through neem oil cake was found best in recording less incidence of insects, pests, diseases and produced higher yield per plant with higher yield and better economic return in okra.

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