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Impact of organic, inorganic fertilizer and integrated nutrient management on disease pest incidence, yield and economics of okra variety-Pusa A-4

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Abstract
Field trial was conducted at the instructional farm of Krishi Vigyan Kendra Jajpur, Odisha during summer 2015 and 2016 to study the impact of Organic, Inorganic Fertilizer and integrated Nutrient Management on disease pest incidence, yield and economics Okra variety-Pusa A-4. From the two years trials 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 31.68% to 18.79%, jassid population from 9.65 to 4.62 per three leaves, mite population from 9.45 to 5.68 per three leaves, white fly population from 11.24 to 4.53 per three leaves and fruit borer from 16.29% to 6.16%. Fruit yield per hectare varied significantly and was maximum with T_7 (9.99 ton) and was minimum with T_{11} (6.96 ton). T_7 (9.99 ton), T_5 (9.44 ton) and T_{10} (9.29 ton) 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.1,39,785/-, net income Rs. 80,302 /- per hectare and maximum benefit cost ratio 2.35.

Keywords: Neem oil cake, vermicompost, disease and pest incidence, INM, yield and okra

Introduction
Okra, (*Abelmoschus esculentus* (L). Moench) belongs to family Malvaceae (2n= 130) is cultivated in 0.509 million hectares area with production of 6.09 million tonnes in India (NHB, 2017-18). It is a popular fruit vegetable grown round the year and fetches premium price in the market. The leading okra producing states in India are Uttar Pradesh, Bihar, Odisha, West Bengal, Andhra Pradesh and Karnatak. 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 great loss in marketable fruit yield. Injudicious use of chemical fertilizers increased the incidence of pests and diseases. Therefore, it is felt necessary to reduce the environmental risk, human health hazards as well as pest population by reducing the levels of inorganic fertilizers with adoption of suitable combinations of organic and inorganic fertilizers under integrated nutrient management system. Hence, the present experiments was conducted to study the impact of organic, inorganic fertilizer and integrated nutrient management on disease pest incidence, yield and economics of okra variety-Pusa A-4.

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 and 2016. The experiment was conducted to study the impact of organic, inorganic fertilizer and integrated nutrient management on disease pest incidence, yield and economics of okra variety-Pusa A-4. The experiment was laid out in randomized block design (RBD) with three replications and twelve treatments. Treatments involved were T_1 (100% RDF), T_2 (100% RDF + FYM 1.5 t / ha), T_3 (RDF (75%) + *Azotobacter* + *Azospirillum* + PSB (2 kg/ha each), T_4 (RDF (75%) + (25%) N through FYM), T_5 (RDF (75%) + (25%) N through vermicompost), T_6 (RDF (75%) + (25%) N through poultry manure), T_7 (RDF (75%) + (25%) N through neem oil cake), T_8 (RDF (50%) + (25%) N through FYM + (25%) N through vermicompost), T_9 (RDF (50%) + (25%) N through FYM + (25%) N through poultry manure), T_{10} (RDF (50%) + (25%) N through FYM + (25%) N through neem oil cake), T_{11} (25% N through FYM + 25% N through vermicompost + 25% N through poultry manure + 25% N through neem oil cake), T_{12} (25% N through FYM + 25% N

through vermicompost + 25% N through poultry manure + 25% N through neem oil cake + sea weed extract 15kg/ha) where RDF was recommended dose of fertilizers (110:50:80 NPK kg/ha.) The land was brought to a fine tilth through ploughing and tillage. Irrigation channels and bunds were prepared according to layout. The seeds were soaked overnight and sown in the field directly. Light irrigation was given just after sowing of seeds. 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 twenty five days after sowing. All cultural practices were followed regularly during crop growth and observations were recorded on yield, yield attributing characters, disease incidence and pest populations. Jassid, 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

From the two years experiment it was observed that population of jassids was lowest (4.62 nymphs per three leaves) in T_7 where 75% of RDF through inorganic fertilizer and 25% through neem oil cake were applied whereas, highest population(9.65 nymphs per three leaves) was recorded in T_2 where 100% RDF + FYM 1.5 t / ha were applied. Comparatively lower population were also found in treatment T_{10} (4.85 nymphs per three leaves) where RDF (50%) + 25% FYM + 25% neem oil cake were applied and in T_5 (5.25 nymphs per three leaves) where 75% RDF through chemical fertilizers + 25% vermicompost were applied. The present findings corroborate with the findings of Kavitha raghavan *et al*. (2005) [9] 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) [16] 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 (T_7) significantly reduced the white fly population from 11.24 to 4.53 per three leaves. Maximum population of 11.24 per three leaves was recorded in the treatment T_2 (100% RDF + FYM 1.5 t / ha) whereas, minimum population of 4.53 per three leaves was found in T_7. However, population of whitefly was also found less in T_{10} (4.81 per three leaves) where 50% RDF + 25% FYM + 25% neem oil cake were applied and T_5 (5.13 per three leaves) where 75% RDF through chemical fertilizers + 25% vermicompost were applied Similar type of result were reported by Joshi M.D. (2011) [8] 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) [1] 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 (5.68 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_{12} (6.12 mite per three leaves per plant) where, (25% N through FYM + 25% N through vermicompost + 25% N through poultry manure + 25% N through neem oil cake + sea weed extract 15kg/ha) were applied, T_{11} (6.48 mite per three leaves per plant) where 25% FYM + 25% vermicompost + 25% poultry manure + 25% neem oil cake were applied, T_{10} (6.41 mite per three leaves per plant) where 50% RDF through chemical fertilizer + 25% through FYM + 25% through neem oil cake were applied and T_5 (6.59 mite per three leaves per plant) where 75% RDF + 25% vermicompost were applied. Whereas, maximum mite population was recorded in T_2 (9.45 per three leaves per plant). Similar type of result were reported by Joshi (2011) [8] 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 at par with treatment where 75 per cent of RDN were applied through poultry manure (1.45 mites per 3 leaves per plant) and vermicompost (1.72 mites per three leaves per plant) and 25 per cent through chemical fertilizer. Similar observations were also reported by Mahto and Yadav (2009) [13].

Significantly lower fruit infestation (6.16%) was found in treatment T_7 where 75% RDF through chemical fertilizer + 25% through neem oil cake were applied. whereas, highest fruit infestation (16.29%) was occurred in T_2 where 100% RDF + FYM 1.5 t / ha were applied. All other treatments differed significantly so far as fruit borer infestation was concerned. Similar type of result was also reported by Adilaxmi *et al*. (2008) [1] 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 observed in the treatment where 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%). (Joshi, 2011) [8].

Considering the disease intensity of yellow vein mosaic in the present experimental trial, the treatment (T_7) where 75% RDF applied through chemical fertilizers and 25% through neem oil cake recorded significantly minimum disease intensity (18.79%). This was at par with T_{12} (20.04%) where (25% N through FYM + 25% N through vermicompost + 25% N through poultry manure + 25% N through neem oil cake + sea weed extract 15kg/ha) were applied. Maximum yellow vein mosaic virus infestation was recorded in T_2 (31.68%) where 100% RDF + FYM 1.5 t / ha were applied. The present findings corroborate with the findings of Tripathy *et al*. (2008) [21] where 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) [8] 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) [1] 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) [7]. 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) [18]

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

Treatments		*Jassid (no.)	*Whitefly (no.)	*Mite (no.)	** Fruit borer (%)	**YVMV (%)
T_1	100% RDF	9.36 (3.14)	11.21 (3.42)	9.28 (3.13)	16.12 (23.67)	31.62 (34.22)
T_2	100% RDF + FYM (1.5 t / ha)	9.65 (3.19)	11.24 (3.43)	9.45 (3.15)	16.29 (23.80)	31.68 (34.25)
T_3	RDF (75%) + *Azotobacter* + *Azospirillum* + PSB (2kg/ha.each)	6.64 (2.67)	9.66 (3.19)	7.96 (2.91)	16.02 (23.59)	25.52 (30.34)
T_4	RDF (75%) + (25%)FYM	7.37 (2.81)	8.87 (3.05)	7.48 (2.82)	14.05 (22.01)	27.00 (31.31)
T_5	RDF (75%) + (25%) VC	5.25 (2.40)	5.13 (2.36)	6.59 (2.66)	9.18 (17.64)	22.46 (28.29)
T_6	RDF (75%) + (25%) PM	6.86 (2.71)	7.89 (2.87)	7.42 (2.81)	1 3.08 (21.20)	25.31 (30.20)
T_7	RDF (75%) + (25%) NOC	4.62 (2.26)	4.53 (2.22)	5.68 (2.49)	6.16 (14.37)	18.79 (25.69)
T_8	RDF (50%) + (25%) FYM + (25%)VC	6.86 (2.71)	6.10 (2.54)	7.28 (2.79)	14.15 (22.10)	23.25 (28.83)
T_9	RDF (50%) + (25%) FYM + (25%)PM	6.92 (2.72)	7.63 (2.79)	7.26 (2.78)	15.20 (22.95)	24.63 (29.75)
T_{10}	RDF (50%) + (25%) FYM + (25%) NOC	4.85 (2.31)	4.81 (2.27)	6.41 (2.63)	8.39 (16.84)	23.09 (28.72)
T_{11}	25% FYM + (25%) VC + (25%) PM + (25%) NOC	5.76 (2.50)	5.77 (2.50)	6.48 (2.64)	8.66 (17.11)	21.13 (27.37)
T_{12}	25% FYM + (25%) VC + (25%) PM + (25%)NOC + SWE(15kg/ha)	5.62 (2.47)	5.34 (2.40)	6.12 (2.57)	8.13 (16.57)	20.04 (26.59)
S.Em (±)		0.06	0.07	0.05	0.33	0.45
CD (0.05)		0.16	0.20	0.15	0.97	1.32

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

Effect of INM on yield

In the present study fruit yield per ha. (9.99 ton) was found maximum with T_7 receiving 75% RDF + 25% neem oil cake which was at par with T_5 (9.44 ton) where 75% RDF + 25% vermicompost were applied. 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 disease and pests. The efficacy of neem cake in reducing incidence of pest in okra was reported by Godase and Patel (2001) [6], Mallick and Lal, (1989) [15] and Tripathy *et al*., 2009) [22]. 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) [18]. 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) [12]. The neem cake apart from improving the soil condition, also built up favourable C/N ratio with appreciably higher content of nutrients (Dahama, 2003) [4] 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 Prasad and Naik. (2013) [19], Mal *et al*. (2014) [14], Choudhary *et al*. (2015) [3], Das *et al*. (2014) [5], Anand *et al*. (2016) [2], Kumar *et al*. (2017) [11] and, Singh *et al*. (2018) in okra.

Effect of INM on economics of okra:

The total cost of cultivation in okra varied from Rs. 46,113/- to Rs. 86,572ha^{-1}. Maximum cost of Rs.86,572/ was incurred in T_{12} where 25% N through FYM + 25% N through vermicompost + 25% N through poultry manure + 25% N through neem oil cake + sea weed extract 15kg/ha were applied. Whereas, minimum cost of Rs. 46,113/ ha^{-1} incurred in T_1 where100% RDF were applied. Highest gross income of Rs. 1,39,785/ were obtained in treatment T_7 whereas lowest of Rs. 90,438/ were obtained in T_3. Similarly highest net return of Rs. 80,302/ were obtained in T_7 where 75% RDF + 25% neem oil cake were applied and was followed by T_5 (73,262/) where 75% RDF + 25% vermicompost were applied. Whereas, lowest of Rs. 16,334/ were obtained in T_{11} where only organic manures were applied. This might be due to that application of 75% RDF through chemical fertilizers + 25% through neem oil cake or vermicompost recorded significantly higher yield, which resulted in higher economic return. Highest B:C ratio (2.35) was observed in T_7 followed by T_5 (2.30) and the lowest B:C ratio of 1.19 was observed in T_{11}. 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) [10], Mal *et al*. (2014) [14] and Tyagi *et al*. (2016) [23].

Table 2: Effect of INM on Economics of okra

Treatments		Yield/ha (ton.)	Cost of cultivation (Rs)	Gross income (Rs)	Net income (Rs)	B:C ratio
T_1	100% RDF	8.60	46,113	1,00,526	54,413	2.18
T_2	100% RDF + FYM (1.5 t / ha)	9.19	47,625	1,05,251	57,626	2.21
T_3	RDF (75%) + *Azotobacter* + *Azospirillum* + PSB (2 kg/ha.each)	7.89	46,142	90,438	44,296	1.96
T_4	RDF (75%) + (25%)FYM	8.31	51,343	1,10,387	59,044	2.15
T_5	RDF (75%) + (25%) VC	9.44	56,356	1,29,618	73,262	2.30
T_6	RDF (75%) + (25%) PM	8.78	51,175	1,08,491	57,316	2.12
T_7	RDF (75%) + (25%) NOC	9.99	59,483	1,39,785	80,302	2.35
T_8	RDF (50%) + (25%) FYM + (25%) VC	8.44	68,573	1,11,088	42,515	1.62
T_9	RDF (50%) + (25%) FYM + (25%) PM	8.13	58,405	1,00,456	42,051	1.72
T_{10}	RDF (50%) + (25%) FYM + (25%) NOC	9.29	70,713	1,24,864	54,151	1.76
T_{11}	25% FYM + (25%) VC + (25%) PM + (25%) NOC	6.96	85,970	1,02,304	16,334	1.19
T_{12}	25% FYM + (25%) VC + (25%) PM + (25%) NOC + SWE(15kg/ha)	7.13	86,572	1,06,752	18,180	1.21
S.Em (±)		0.29		-	-	-
CD (0.05)		0.86		-	-	-

Conclusion

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 and better economic return in okra.

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