Plant Archives Vol. 26, No. 2, 2026 pp. 1712-1716 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org

DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2026.v26.no.2.232

RESPONSE OF MULCHING AND FOLIAR NUTRITION OF NPK ON POD YIELD, QUALITY AND ECONOMICS OF OKRA (*Abelmoschus esculentus* L. MOENCH)

Narendra Mohan Sharma, Vishwa Nath*, Pushpansh Katara and Tosha Pandey

Department of Horticulture, Raja Balwant Singh College (Dr Bhimrao Ambedkar University, Agra) Bichpuri, Agra, Uttar Pradesh 283105, India

*Corresponding author E-mail: vnmishra.hort@gmail.com

(Date of Receiving-14-07-2026; Date of Revision-12-09-2026; Date of Acceptance-22-09-2026)

ABSTRACT

A field experiment was conducted during the kharif season of 2025 at the Agricultural Research Farm of Raja Balwant Singh College, Bichpuri, Agra, to evaluate the individual and combined effects of mulching and foliar NPK nutrition in okra (*Abelmoschus esculentus* L. Moench cv. Arka Anamika). The trial comprised three mulching treatments, viz. no mulch (M0), black polythene mulch (M1) and straw mulch (M2), and three foliar NPK (19:19:19) concentrations, viz. no spray (NPK0), 0.5% solution (NPK1) and 1.0% solution (NPK2), arranged in a factorial randomized block design with three replications. Black polythene mulch recorded significantly superior values for pods plant^{-1} (31.54), pod length (15.01 cm), pod weight (15.21 g) and pod girth (2.59 cm) over straw mulch and control, resulting in a fruit yield of 62.61 q ha^{-1} (at par with straw mulch at 59.08 q ha^{-1}). Foliar feeding with 1.0% NPK produced the highest fruit yield (67.52 q ha^{-1}). Among interaction combinations, M1NPK2 recorded the maximum fruit yield (78.93 q ha^{-1} / 65.07 q ha^{-1} marketable), dry matter accumulation (fruit 10.74 g and leaf 10.39 g/100 g), gross income (Rs.-2,60,268 ha^{-1}), net return (Rs.1,92,224 ha^{-1}) and benefit–cost ratio (2.82). Black polythene mulching combined with two foliar sprays of 1.0% water-soluble NPK is recommended as a highly profitable practice for okra cultivation under semi-arid conditions.

***Key words*:** Okra, Mulching, Foliar spray, NPK, yield attributes, benefit–cost ratio

Introduction

Okra (*Abelmoschus esculentus* L. Moench, family Malvaceae), commonly known as bhendi or lady's finger, is one of the most popular warm-season vegetable crops grown throughout the tropics and sub-tropics. In India it occupies a prominent position among the vegetable crops and is cultivated almost round the year wherever irrigation is available, although the kharif sowing is the most extensive. The tender pods are consumed as a vegetable and are a good source of carbohydrates, protein, minerals, vitamins A and C, and dietary fibre besides the characteristic mucilage. Being a short-duration crop that yields steady pickings over six to eight weeks, okra provides regular cash returns to small and marginal growers. Nevertheless, field-level productivity often remains far below the potential, mainly because of erratic rainfall, moisture stress at critical stages, heavy weed infestation during the early phase and imbalanced nutrient management (Kumar & Pal, 2020; Meena *et al.*, 2024).

Under the semi-arid conditions of western Uttar Pradesh, conservation of rain water and reduction of surface evaporation assume great importance in kharif vegetables. Mulching of the soil surface is a well-known moisture-conservation practice which also suppresses weed emergence, moderates fluctuations in soil temperature and, in the case of organic mulches, adds organic matter on decomposition (Bhutia *et al.*, 2017; Saha *et al.*, 2020). Black polythene film is particularly effective in checking evaporation and restricting weed growth, whereas straw mulch is inexpensive, locally

available and improves the physical condition of the soil as it decays; the relative advantage of the two mulches, however, varies with crop, soil and rainfall pattern, and their cost has to be weighed against the yield benefit they generate (Okorie *et al.*, 2024; Tadesse *et al.*, 2024).

Nutrient supply is equally decisive, especially during flowering and pod development when the demand for nitrogen, phosphorus and potassium rises sharply. Foliar application of water-soluble fertilizers at this stage supplies nutrients directly through the leaves and avoids the losses associated with soil application under moisture-limited conditions (Fernández & Brown, 2013). Balanced NPK (19:19:19) sprays at low concentration have been reported to improve pod setting, pod weight and overall fruit yield of okra, and mulched crops generally show a stronger response to such sprays because of the more favourable moisture regime (Deepthi *et al.*, 2024; Madhumitha & Sundaram, 2025). Since both mulching and foliar nutrition involve additional expenditure, their adoption has to be justified through yield as well as profitability (Ghuge *et al.*, 2024; Lakshmi *et al.*, 2023). Information on the interactive effect of mulch material and foliar NPK concentration on yield components, dry matter partitioning and economics of okra under the agro-climatic conditions of Agra is limited. The present investigation was, therefore, undertaken to quantify these effects and to identify an economically viable mulch–nutrition combination for okra growers of the region.

Materials and Methods

The field experiment was conducted during the kharif season of 2025 at the Agricultural Research Farm of the Department of Horticulture, Raja Balwant Singh College, Bichpuri, Agra, Uttar Pradesh (27°02' N latitude, 77°09' E longitude and 163.4 m above mean sea level). The climate of the site is semi-arid subtropical characterized by extreme temperatures and erratic monsoon rains, with total seasonal precipitation of about 580 mm recorded during July to September 2025. The experimental field soil was Gangetic alluvial sandy loam (fine sand 56.43%, silt 20.94%, clay 19.54% and coarse sand 0.30%), slightly alkaline in reaction (pH 8.11), with electrical conductivity of 1.58 dS m^{-1}, low organic carbon (0.31%), low available nitrogen (178.22 kg ha^{-1}), medium available phosphorus (26.25 kg P_2O_5 ha^{-1}) and high available potassium (267.43 kg K_2O ha^{-1}). The trial was laid out in a 3 × 3 factorial randomized block design with three replications, comprising nine treatment combinations: three mulching materials—no mulch (M0), black polythene mulch of 25 µm thickness (M1) and paddy straw mulch applied @ 6 t ha^{-1} (M2)—and three foliar NPK (19:19:19) spray concentrations—no spray (NPK0), 0.5% solution (NPK1) and 1.0% solution (NPK2). Each experimental plot measured 3.375 m² (2.25 m × 1.5 m) gross area and 2.16 m² (1.8 m × 1.2 m) net area. Seeds of yellow vein mosaic virus-resistant okra cv. 'Arka Anamika' were dibbled on 12th July 2025 at a spacing of 45 cm × 30 cm (two seeds $hill^{-1}$, later thinned to single plant $hill^{-1}$ at 25 days after sowing). A recommended uniform basal dose of 100:60:60 kg N, P_2O_5 and K_2O ha^{-1} was applied through urea, DAP and muriate of potash; entire P and K along with half N were applied basal and the remaining half N was top-dressed at 30 DAS. Black polythene film was spread prior to sowing, whereas straw mulch was applied after crop establishment. Foliar sprays of water-soluble NPK (19:19:19) were administered at 30 and 45 DAS using a knapsack sprayer with fine nozzle at 500 L ha^{-1} volume containing 0.1% Teepol as surfactant. Five tagged plants per plot were used for recording observations on pods $plant^{-1}$, pod length, individual pod weight and pod girth. For dry matter, 100 g fresh samples of pods and leaves were oven-dried at 65 ± 2 °C to constant weight. Marketable pods were harvested at 3- to 4-day intervals from the net plot area and cumulative yields were recorded as yield $plot^{-1}$ (kg) and fruit yield (q ha^{-1}). Cultivation economics were computed based on the prevailing local wholesale produce price of Rs. 4,000 q^{-1} and a common cultivation cost of Rs. 52,428 ha^{-1} added to treatment costs. Experimental data were subjected to analysis of variance as outlined by Panse and Sukhatme (1967), and treatment differences were tested using critical difference at the 5% probability level.

Results and Discussion

The analysis of variance showed significant differences among treatments for most of the characters studied. The treatment means for yield components, dry matter traits, yield and economic indicators are presented in Tables 1 to 4 and discussed below.

Yield attributes

Pods $plant^{-1}$, pod length, pod weight and pod girth differed significantly among mulch and foliar NPK treatments (Table 1). Among the mulch levels, black polythene mulch recorded the highest pods $plant^{-1}$ (31.54), pod length (15.01 cm), pod weight (15.21 g) and pod girth (2.59 cm), and these values were superior to those of straw mulch and the unmulched control. Foliar feeding followed a similar trend, the corresponding means being highest with 1.0% NPK (31.96 pods $plant^{-1}$, 14.94 cm, 15.00 g and 2.68 cm, respectively) and lowest where no spray was given. The interaction means showed that M1NPK2 produced 32.70 pods $plant^{-1}$ with 15.44 cm

Table 1: Effect of mulching, foliar NPK and their interaction on pods plant^{-1}, pod length, pod weight and pod girth of okra.

Treatment	NPP	PL	PW	PG
Effect of Mulching				
No mulch (M0)	28.90	13.43	12.55	1.62
Black polythene mulch (M1)	31.54	15.01	15.21	2.59
Straw mulch (M2)	29.30	14.12	13.33	2.24
SEm±	**0.385**	**0.031**	**0.407**	**0.140**
CD (P=0.05)	**1.153**	**0.094**	**0.863**	**0.422**
Effect of Foliar Spray of NPK				
No spray (NPK0)	28.69	13.50	12.22	1.72
0.5% NPK (NPK1)	29.09	14.11	13.88	2.05
1.0% NPK (NPK2)	31.96	14.94	15.00	2.68
SEm±	**0.385**	**0.031**	**0.407**	**0.140**
CD (P=0.05)	**1.153**	**0.094**	**0.863**	**0.422**
Interaction Effect of Mulching and Foliar Spray of NPK				
M0NPK0	27.22	13.00	11.11	1.82
M0NPK1	27.31	13.44	12.22	1.92
M0NPK2	29.74	13.84	14.33	2.20
M1NPK0	30.65	14.02	13.89	1.93
M1NPK1	29.91	14.53	14.66	2.16
M1NPK2	32.70	15.44	15.55	2.67
M2NPK0	32.23	14.66	14.33	2.57
M2NPK1	29.46	13.86	13.00	2.43
M2NPK2	29.14	14.50	14.55	2.58
SEm± (interaction)	**0.667**	**0.054**	**0.705**	**0.242**
CD (P=0.05; interaction)	**1.996**	**0.163**	**1.494**	**0.730**

NPP: No. of Pods plant^{-1}; PL: Pod length (cm); PW: Pod weight (g); PG: Pod girth (cm)

pod length, 15.55 g pod weight and 2.67 cm pod girth, and the number of pods under this combination was statistically at par with M2NPK0 (32.23 pods plant^{-1}). The minimum values of all the pod traits were obtained with M0NPK0. The improvement in pod development under mulch may be ascribed to better availability of soil moisture and a more favourable root-zone environment during flowering and pod filling, while foliar NPK apparently met the peak nutrient demand at the reproductive stage (Changade *et al.*, 2023; Lakshmi *et al.*, 2023).

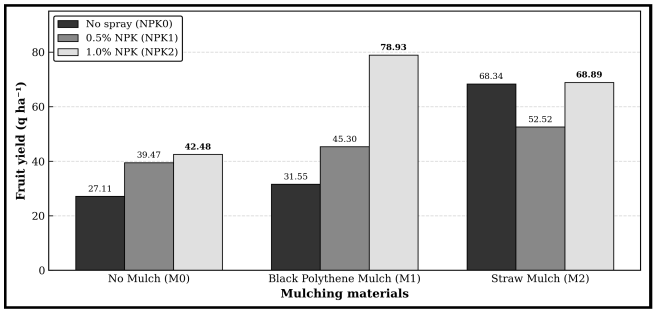

Fig. 1: Effect of mulching, foliar NPK and their interaction on fruit yield (q ha^{-1}) of okra.

Table 2: Effect of mulching, foliar NPK and their interaction on fruit and leaf dry weight of okra.

Treatment	FDW	LDW
Effect of Mulching		
No mulch (M0)	8.97	7.97
Black polythene mulch (M1)	9.52	10.02
Straw mulch (M2)	10.15	8.76
SEm±	**0.287**	**0.269**
CD (P=0.05)	**0.861**	**0.806**
Effect of Foliar Spray of NPK		
No spray (NPK0)	8.70	8.36
0.5% NPK (NPK1)	10.23	8.82
1.0% NPK (NPK2)	9.71	9.56
SEm±	**0.287**	**0.269**
CD (P=0.05)	**0.861**	**0.806**
Interaction Effect of Mulching and Foliar Spray of NPK		
M0NPK0	8.58	7.01
M0NPK1	8.90	7.65
M0NPK2	8.77	8.44
M1NPK0	8.76	8.94
M1NPK1	9.63	9.67
M1NPK2	10.74	10.39
M2NPK0	10.29	9.76
M2NPK1	9.22	8.46
M2NPK2	10.01	8.74
SEm± (interaction)	**0.49**	**0.66**
CD (P=0.05; interaction)	**NS**	**NS**

FDW: Fruit dry weight (g/100 g); LDW: Leaf dry weight (g/100 g)

Dry matter production

Mulch material influenced the partitioning of dry matter between fruit and foliage (Table 2). Black polythene mulch produced the highest fruit dry weight (10.23 g/100 g) and leaf dry weight (10.02 g/100 g), while straw mulch recorded 9.71 g and 8.76 g/100 g, respectively, both being significantly superior to the unmulched control. With respect to foliar nutrition, fruit dry weight was greatest at 1.0% NPK (10.15 g/100 g)

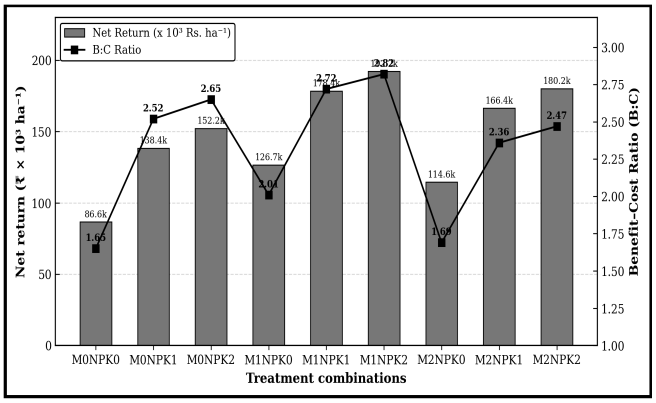

Fig. 2: Net return (Rs. ha^{-1}) and benefit–cost ratio of okra as influenced by mulching and foliar NPK.

Table 3: Effect of mulching, foliar NPK and their interaction on yield of okra.

Treatment	YP	PY
Effect of Mulching		
No mulch (M0)	1.26	37.35
Black polythene mulch (M1)	2.11	62.61
Straw mulch (M2)	1.99	59.08
SEm±	**0.127**	**3.779**
CD (P=0.05)	**0.382**	**11.33**
Effect of Foliar Spray of NPK		
No spray (NPK0)	1.08	32.18
0.5% NPK (NPK1)	2.00	59.35
1.0% NPK (NPK2)	2.28	67.52
SEm±	**0.127**	**3.779**
CD (P=0.05)	**0.382**	**11.33**
Interaction Effect of Mulching and Foliar Spray of NPK		
M0NPK0	0.91	27.11
M0NPK1	1.33	39.47
M0NPK2	1.43	42.48
M1NPK0	1.06	31.55
M1NPK1	1.53	45.30
M1NPK2	2.66	78.93
M2NPK0	2.30	68.34
M2NPK1	1.77	52.52
M2NPK2	2.32	68.89
SEm± (interaction)	**0.221**	**6.546**
CD (P=0.05; interaction)	**0.661**	**19.62**

YP: Yield plot^{-1} (kg); PY: Pod Yield (q ha^{-1})

and leaf dry weight also at 1.0% NPK (9.56 g/100 g). The mulch × NPK interaction remained non-significant for both characters; therefore, the numerical differences among interaction means are only indicative. Among the combinations, M1NPK2 accumulated the highest fruit (10.74 g/100 g) and leaf (10.39 g/100 g) dry weights. The greater assimilate build-up under mulch combined with foliar feeding is consistent with the larger pod load recorded in these plots, as mulch conserved moisture for sustained assimilation while foliar sprays supplied nutrients at the pod-filling stage (Madhumitha & Sundaram, 2025; Deepthi *et al*., 2024).

Pod yield

Pod yield responded markedly to both mulching materials and foliar NPK nutrition levels (Table 3, Fig. 1). Among the mulching treatments, black polythene mulch (M1) produced the highest pod yield of 2.11 kg plot' (62.61 q ha^{-1}), which was statistically at par with straw mulch (1.99 kg plot^{-1} and 59.08 q ha^{-1}) and significantly superior to the unmulched control (1.26 kg plot^{-1} and 37.35 q ha^{-1}), registering a yield advantage of 67.6% over the control. With respect to foliar NPK nutrition, application of 1.0% NPK (NPK2) recorded the maximum pod yield of 2.28 kg plot^{-1} (67.52 q ha^{-1}), which remained statistically at par with 0.5% NPK (2.00 kg plot^{-1} and 59.35 q ha) and was significantly superior to the unsprayed control (1.08 kg plot^{-1} and 32.18 q ha^{-1}). The interaction effect between mulching materials and foliar NPK sprays also exhibited significant differences. The combination MINPK2 (black polythene mulch + 1.0% NPK spray) produced the highest pod yield of 2.66 kg plot^{-1} (78.93 q ha^{-1}), remaining statistically at par with M2NPK2 (2.32 kg plot^{-1} and 68.89 q ha) and M2NPKO (2.30 kg plot^{-1} and 68.34 q ha). Conversely, the unmulched unsprayed control (MONPKO) recorded the lowest pod yield of 0.91 kg plot^{-1} (27.11 q ha^{-1}). The additive response indicates that mulch effectively conserved root-zone moisture and reduced weed competition while foliar NPK feeding supplied balanced macronutrients during peak pod development, in conformity with earlier findings (Varughese *et al*., 2014; Ghatage *et al*., 2024).

Table 4: Economics of okra cultivation under mulching and foliar NPK spray.

Treatment	FY	GI	CC	NR	BC
M0NPK0	34.77	1,39,066	52,428	86,638	1.65
M0NPK1	48.35	1,93,394	54,986	1,38,408	2.52
M0NPK2	52.44	2,09,748	57,544	1,52,204	2.65
M1NPK0	47.40	1,89,586	62,928	1,26,658	2.01
M1NPK1	60.98	2,43,914	65,486	1,78,428	2.72
M1NPK2	65.07	2,60,268	68,044	1,92,224	2.82
M2NPK0	45.63	1,82,526	67,928	1,14,598	1.69
M2NPK1	59.21	2,36,854	70,486	1,66,368	2.36
M2NPK2	63.30	2,53,208	73,044	1,80,164	2.47

FY: Fruit yield (q ha^{-1}); GI: Gross income (Rs. ha^{-1});
CC: Cost of cultivation (Rs. ha^{-1});
NR: Net return (Rs. ha^{-1}); BC: B:C ratio

Economics of cultivation

The economics of cultivation reflected the yield differences among the treatments (Table 4, Fig. 2). Owing to its higher fruit yield, M1NPK2 recorded the highest gross income (Rs. 2,60,268 ha^{-1}), net return (Rs. 1,92,224 ha^{-1}) and benefit–cost ratio (2.82). M1NPK1 (2.72) and M0NPK2 (2.65) were the next best combinations. Although the straw-mulched plots of M2NPK2 gave a yield comparable with M1NPK2, the cost of straw mulching was higher than that of polythene film, which narrowed the net advantage; for the same reason M2NPK0 registered a lower benefit–cost ratio (1.69). The lowest net return occurred under M0NPK0 (Rs. 86,638 ha^{-1}). The results confirm that the extra investment on polythene mulch and foliar NPK was more than compensated by the additional income, in agreement with earlier economic evaluations in okra (Meena *et al*., 2024; Ghuge *et al*., 2024).

Conclusion

The results indicated that both mulch material and foliar NPK concentration governed the performance of okra. Black polythene mulch proved superior for pod traits and fruit yield, whereas straw mulch also showed comparable performance. The combination of black polythene mulch with 1.0% foliar NPK (M1NPK2) recorded 78.93 q ha^{-1} (65.07 q ha^{-1} marketable), gross income of Rs. 2,60,268 ha^{-1}, net return of Rs. 1,92,224 ha^{-1} and a benefit–cost ratio of 2.82, and its yield was at par with M2NPK2 (68.89 q ha^{-1}). Black polythene mulching coupled with two sprays of 1.0% water-soluble NPK may, therefore, be adopted as a profitable production practice for okra under similar agro-climatic conditions (Bhutia *et al*., 2017; Ghatage *et al*., 2024).

References

Bhutia, T.L., Singh S.H. and Reddy K.C.S. (2017). Effect of mulching and nitrogen on growth, yield and economics of okra (*Abelmoschus esculentus*). *Ecology Environment and Conservation*, **23(2)**, 826–832.

Changade, N.M., Sharma V. and Kumar R. (2023). Performance of okra (*Abelmoschus esculentus*) to different irrigation levels and mulches under drip irrigation system. *The Indian Journal of Agricultural Sciences*, **93(3)**, 318–320.

Deepthi, C., Vangapandu T., Ganisetti A. and Ganesh P. (2024). Enhancing okra growth and yield through foliar nutrient application in conjunction with mulching and drip irrigation. *Agricultural Science Digest. Advance online publication*.

Fernández, V. and Brown P.H. (2013). From plant surface to plant metabolism: The uncertain fate of foliar-applied nutrients. *Frontiers in Plant Science*, **4**, 289.

Ghatage, A.V., Mane M.S., Khedkar D.D., Danawale N.J., Kale K.D., Ghodake S.K. and Patil V.S. (2024). Effect of nano urea on growth, yield and water productivity of okra under fertigation in Inceptisols. *International Journal of Current Microbiology and Applied Sciences*, **13(12)**, 292–298.

Ghuge, S.U., Bodake P., Thorat T., More S., Sanap S., Patil S.P., Chavan Y., Bhave K. and Raut K.S. (2024). Growth, yield and economics of okra (*Abelmoschus esculentus* L.) as influenced by foliar sprays of nano fertilizers. *International Journal of Research in Agronomy*, **7(10)**, 335–339.

Kumar, T. and Pal S.L. (2020). Effect of different doses of NPK fertilizers on growth, yield and yield attributes of okra (*Abelmoschus esculentus* (L.) Moench.) cv. 'Arka Anamika'. *International Journal of Current Microbiology and Applied Sciences*, **9(Special Issue-11)**, 3309–3312.

Lakshmi, B., Pooja B., Akshitha C., Anjali D., Haripriya G. and Srivalli R. (2023). Effect of irrigation levels on growth and yield of okra under mulching. *Research Highlights in Agricultural Sciences*, **9**, 90–97.

Madhumitha, M. and Sundaram V. (2025). Effect of nano urea and micronutrient foliar application on growth and yield of bhendi [*Abelmoschus esculentus* (L.) Moench]. *Plant Science Today*, **12(sp4)**.

Meena, A.R., Narolia R.K., Yadav P.K., Lata K. and Meena S. (2024). Improvement in yield and quality of okra (*Abelmoschus esculentus*) through crop spacing, mulching and irrigation levels in arid regions. *The Indian Journal of Agricultural Sciences*, **94(3)**, 270–275.

Okorie, B.O., Obi J.O., Chioke G.U., Obalum S.E., Onah C.J., Nnadi A.L., Igwe C.A. and Obi M.E. (2024). The concept of bio-economic mulching in droughty tropical agroecosystems and its trans-season effects on soil hydro-thermal regime and okra performance. Sains Tanah: *Journal of Soil Science and Agroclimatology*, **21(2)**, 165–178.

Panse, V.G. and Sukhatme P.V. (1967). Statistical methods for agricultural workers. *Indian Council of Agricultural Research*.

Saha, S., Chandrashekar S., Sonke L.R. and Mahapatro G.K. (2020). Efficacy of rice straw mulch for the sustainable production and insect pest management in okra (*Abelmoschus esculentus*). *The Indian Journal of Agricultural Sciences*, **90(10)**, 1865–1870.

Tadesse, S., Fantaw S. and Tagele A. (2024). Evaluation of the pod yield and quality of okra (*Abelmoschus esculentus* L. Moench) varieties cultivated on mulching materials in northwestern *Ethiopia*. *Discover Plants*, **1**, 39.

Varughese, A., Menon J.S. and Mathew E.K. (2014). Effect of fertigation levels and drip system layout on performance of okra under plastic mulch. *Journal of Agricultural Engineering*, **51(4)**, 28–32.