



Productivity and Profitability of Sesame / Green Gram / Urdbean – Mustard Based Cropping Systems under Moisture Conservation Practices

Radha Morya ^{a++}, Anjni Mastkar ^b, Rahul Morya ^{c#},
Anjali Bhargava ^{c##} and H. S. Kushwaha ^{dt}

^a Banda University of Agriculture and Technology, Banda (U.P), India.

^b Cost of Cultivation Scheme, Agriculture Economics and Farm Management JNKVV, Jabalpur (M.P), India.

^c Department of Soil Science, RVSKVV, Gwalior (M.P), India.

^d Department of Natural Resource Management, MGCGV, Chitrakoot, Satna (M.P.), India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A field experiments was conducted on sandy loam soil during 2016 -17 and 2017 -18 at M.G. chitrakoot Gramodaya Vishwavidyalaya, Chitrakoot, Satna (M.P.) to find out the most productive and profitable mustard based cropping system under different moisture conservation practices. Treatment consisted three cropping systems viz. Sesame –mustard, green gram-mustard and

⁺⁺ Programme Assistant (Agronomy);

[#] Ph.D. Scholar;

[†] Professor (Agronomy);

*Corresponding author: E-mail: anjali bhargava003@gmail.com;

urdbean –mustard and four moisture conservation practices (no irrigation, life saving irrigation, straw mulch @4 t/ha and kaolin 5% spray). Results revealed that on pooled basis of two years mulching @4 t/ha produced significantly higher grain yield of sesame (512 kg/ha), green gram (1023 kg/ha) urdbean (2349 kg/ha) and mustard (2558kg/ha) than no irrigation while numerical enhancement were recorded under life saving irrigation and kaolin 5 % spray treatment in seed yield of sesame, green gram, urdbean and mustard crop. The maximum mustard equivalent grain yield of 3759 kg/ha, system production efficiency of 33.52 kg/ha/day and system profitability of 339.00 Rs/ha/day was recorded under green gram – mustard system. Among the moisture conservation practices, straw mulch treatment had highest mustard equivalent grain yield of 4021 kg/ha, production efficiency of 35.83 kg/ha/day and system profitability (35.83 Rs/ha/day). The gross returns (Rs 182764/ha), net returns (Rs 139644/ha) and benefit: cost ratio (3.24) were maximized under green gram- mustard system x straw mulch @4 t/ha treatment on pooled basis.

Keywords: Productivity; profitability; mustard; sesame; green gram; urdbean; gross return; net return; mustard equivalent grain yield.

1. INTRODUCTION

“Indian mustard (*Brassica juncea* L.) s one of the most important winter oil seed crop grown in northern parts of India, the area, production and productivity of mustard in India during 2018-19 were 6.23 mha, 9.34 mt and 1499 kg/ha, respectively (DAC,2019). In India, it is mainly cultivated in Rajasthan, Uttar Pradesh, Madhya Pradesh, Haryana and Gujarat. The seeds are high in essential oils as well as plant sterols and source of essential B complex vitamins such as folates, niacin, thiamin, riboflavin, pyridoxine (vitamin B-6), pantothenic acid. Oil cake is a byproduct left after extraction of oil, is used as manure which is rich in nitrogen. Yield of mustard is greatly influenced by irrigation. Non availability of irrigation water as per requirements of mustard crop causes moisture stress at critical stages of growth and development. Under such circumstances to findout some appropriate solution without scarifying yield” [1]. Life saving irrigation, mulching and antitranspirant (kaolin) as a viable option for conserving

the moisture and its synergistic response to the applied inputs. Mulch acts as a barrier with effectively blocks the transport of vapours out of the soil (soil evaporation) and alters the net radiation at soil surface which check soil evaporation reduced weed growth. Antitranspirant (kaolin) reduced the rate of transpiration from plant leaves by reducing the size and number of stomata. Life saving irrigation net the water requirement which is most essential for survival of plant.

“Sesame (*Sesamum indicum* L.) the ancient oil seed crop in India. Its seed contains 5 % oil and 25 % protein, vitamins, minerals antioxidants. It is successfully grown during rainy season but its

productivity is low because it is grown in marginal lands with least external nutrients supply and limited irrigation. This crop is dominantly due to water stress and weed infestation which can cause a yield falling of upto 86.3 % in sesame” [2,3].

“Greengram [*Vigna radiate* (L) wilczek] and blackgram (*vigna mungo*) is an important pulse crop grown during rainy season in almost all the region due to its triple use for food, fodder and fertility. Besides in Madhya Pradesh these crops are being grown in Maharashtra, Andhra Pradesh, Uttar Pradesh, Rajasthan and Bihar. In Madhya Pradesh their crops are grown in nimar, malwa, satpura, tawa and Chambal valley during kharif season. Their crops are rich in protein (21-25 %). The average productivity of these crops is low and the production is not sufficient to meet out the per capita requirement” [1]. These crops are mostly grown sub marginal land under rainfed/ dryland conditions. The moisture conservation is one of the most important constraints to increase the production of these crops. With these views present investigation was under taken with different moisture conservation practices.

2. MATERIALS AND METHODS

The present field experiment was carried out during two consecutive years (2016-17 and 2017- 18) at M.G. chitrakoot Gramodaya Vishwavidyala, Chitrakoot, satna (m.p.). Treatment consisted three cropping systems i.e. sesame – mustard, greengram- mustard and urdbean – mustard and four moisture conservation practices (no irrigation, life saving irrigation, no irrigation + straw mulch @ 4 t/ha and no irrigation + kaolin 5% spray).Thus 12 treatment combinations in rabi season and four

treatments in rainy season were tried in a three replicated randomized block design. The soil of the experimental field was sandyloam in texture having soil pH 7.6, organic carbon 0.51 %, available nitrogen 168 kg/h, available phosphorous 17.8 kg/ha and available potassium 350 kg/ha. The seed rate used in sesame (cv. RT- 351) @ 5 kg, greengram (PDM -139) @ 15 kg, urdbean (Azad -1) @15 and mustard (Pusa mahak) @ 5 kg/ha. The sesame / greengram/ urdbean were sown on 15 July 2016 and 17 July 2017 at a row spacing of 30 cm in furrows and mustard was sown on 02 November 2017 and 03 November 2018 in furrows at a row spacing were of 45 cm apart. 15 DAS the plant spacing of sesame /greengram/urdbean was maintained at 10 cm and in mustard at 15 cm apart with thinning operation. The sesame crop was fertilized @ 30:60:30 kg NPK, Greengram / urdbean @ 120: 60:30 kg N.P.K/ha. Moisture conservation practices were applied in rainy and winter season crops separately. In rainy season sesame /greengram/urdbean, life saving irrigation was given 35 DAS, straw mulch @ 4t/ha was spread in the plots 30 DAS and kaolin 5% sprayed 35 DAS. In mustard crop, life saving irrigation was applied 35 DAS, straw mulch @ 4 t/ha through paddy straw 30 DAS and kaolin 5 % spray was done 35 DAS during both years of experimentation. Remaining input cum operation was done as per need of crop except irrigation in all crops. The sesame crop was harvested on 18 October 2016 and 20 October 2017, green gram crop on 18 October 2016 and 20 October 2017, and urdbean on 18 October 2016 and 20 October 2017 and mustard crop on 01 April 2017 and 05 April 2018. The yield (grain and straw) of crop were recorded plot wise and later on converted into kg/ha. The mustard equivalent grain yield, production efficiency and profitability of the systems were calculated with the help of following formula:

$$\text{Mustard equivalent grain yield} = \frac{\text{Yield of crop (kg/ha)} \times \text{Price of yield (₹ /ha)}}{\text{Price of mustard yield (₹ kg)}}$$

System production efficiency = (Mustard equivalent grain yield of particular crop sequence)/(Duration of particular cropping system)

$$\text{System profitability} = \frac{\text{Total net returns}}{\text{Duration of cropping system (365 days)}}$$

The cost of cultivation, gross return, net return and benefit: cost ratio was calculated in all crops and sum was presented here. All the information's are provided here on pooled value basis.

3. RESULTS AND DISCUSSION

3.1 Seed and Stover Yield of Sesame

It is apparent from Table 1 that significantly maximum grain yield (512kg /ha) and stover yield (2661kg/ha) of sesame was recorded under straw mulch followed by life saving irrigation treatment than without irrigation (449 kg/ha grain and 2336kg/ha stover). Life saving irrigation, straw mulch and kaolin 5 % spray treatment improved grain and stover yield by 21 and 98 kg/ha, 63 and 325 kg/ha and 10 and 49 kg/ha over no irrigation, respectively. It was probably due to better growth and yield attributes of sesame due to beneficial effect of moisture conservation practices. Goitom teame et al (2017) supported the findings. Life saving irrigation provide moisture for essential metabolic process of crop, straw mulch helps to reduce evaporation of soil moisture from soil surface, reduced weed growth and maintained soil temperature while kaolin 5 % spray reduced loss from leaves (transpiration).

3.2 Seed and Stover Yield of Greengram

Data available in Table 1 makes it clear that on pooled basis the seed and stover yield of greengram was significantly maximum seed and stover yield of greengram were produced by straw mulch treated plants (1023 kg grain and 2610 kg/ha stover) than no irrigation. Life saving irrigation, straw mulch and kaolin 5 % spray increased grain yield by a margin of 37, 124 and 18 kg/ha, stover yield by 96 , 419 and 38 kg/ha over no irrigation, respectively. It was may be due to superior growth and yield attributes of greengram under moisture conservation practices. Dutta et al [4] confirmed the findings.

3.4 Seed and Stover Yield of Urdbean

It is evident from Table 1 that life saving irrigation and straw mulch treatment produced significantly higher seed and stover yield of urdbean than without irrigation but maximized under straw mulch (921 kg grain and 2349 kg stover/ha). The increment in seed yield of urdbean was by a

Table 1. Effect of moisture conservation practices on grain and stover yield of sesame, green gram, urdbean, and mustard crop on the pooled basis (during 2016-17 and 2017- 18)

| Moisture conservation practices | Sesame grain yield (kg/ha) | Sesame stover yield (kg/ha) | Green gram grain yield (kg/ha) | Green gram stover yield (kg/ha) | Urd bean grain yield (kg/ha) | Urd bean stover yield (kg/ha) | Mustard grain yield (kg/ha) | Mustard stover yield (kg/ha) |
|--|-----------------------------------|------------------------------------|---------------------------------------|--|-------------------------------------|--------------------------------------|------------------------------------|-------------------------------------|
| No irrigation | 449 | 2336 | 899 | 2291 | 809 | 2062 | 2246 | 4742 |
| Life saving irrigation | 468 | 2434 | 936 | 2387 | 842 | 2148 | 2340 | 4940 |
| Straw mulch | 512 | 2661 | 1023 | 2610 | 921 | 2349 | 2558 | 5401 |
| Kaolin 5% spray | 459 | 2385 | 917 | 2339 | 826 | 2105 | 2293 | 4841 |
| S.E.M. ± | 5.53 | 28.53 | 10.88 | 28.00 | 9.83 | 25.19 | 18 | 47 |
| C.D.(P=0.05) | 16.59 | 85.58 | 32.65 | 84.00 | 29.49 | 75.58 | 53 | 220 |

Table 2. Effect of cropping system and moisture conservation practices on mustard equivalent grain yield (kg/ha), production efficiency of grain (kg/ha/day) and system profitability (Rs/ha/day) pooled of two years (2016 -17 and 2017- 18)

| Treatment | Mustard equivalent grain yield (kg/ha) | System profitability (Rs/ha/day) | Production efficiency of grain (kg/ha/day) |
|--|---|---|---|
| Cropping system | | | |
| Sesame – mustard | 3653 | 285.8 | 32.53 |
| Green gram – mustard | 3759 | 339.0 | 33.52 |
| Urdbean –mustard | 3711 | 289.3 | 33.08 |
| S.E.M. ± | 17.8 | 9.0 | 0.17 |
| C.D.(P=0.05) | 52.8 | 26.6 | 0.49 |
| Moisture conservation practices | | | |
| No irrigation | 3529 | 283.3 | 31.46 |
| Life saving irrigation | 3677 | 300.0 | 32.77 |
| Straw mulch | 4021 | 342.0 | 35.83 |
| Kaolin 5% spray | 3604 | 293.3 | 32.12 |
| S.E.M. ± | 55.4 | 6.6 | 0.49 |
| C.D.(P=0.05) | 164.0 | 19.6 | 1.46 |

Table 3. Effect of cropping system and moisture conservation on cost of cultivation (Rs./ha) gross returns (Rs./ha), net returns (Rs./ha) and benefit: Cost ratio of the system (pooled of two years)

| Treatment | Cost of cultivation (Rs/ha) | Gross returns (Rs/ha) | Net returns (Rs/ha) | Benefit: cost ratio |
|------------------|------------------------------------|------------------------------|----------------------------|----------------------------|
| S- M x NI | 45440 | 142840 | 97400 | 2.14 |
| S- M x LSI | 45540 | 148880 | 103340 | 2.27 |
| S-M x SM | 45482 | 161691 | 116209 | 2.56 |
| S-M x kaolin | 45374 | 145891 | 100517 | 2.22 |
| G-M x NI | 45412 | 160173 | 114761 | 2.53 |
| G- M x LSI | 45440 | 166757 | 121317 | 2.67 |
| G -M x SM | 43120 | 182764 | 139644 | 3.24 |
| G- M x kaolin | 43976 | 163435 | 119459 | 2.72 |
| U- M x NI | 45364 | 143596 | 98232 | 2.17 |
| U-M x LSI | 45362 | 149560 | 104198 | 2.30 |
| U-M x SM | 45440 | 164187 | 118747 | 2.61 |
| U- M x kaolin | 45312 | 146603 | 101291 | 2.24 |

margin of 33, 112 and 17 kg/ha under life saving irrigation, straw mulch and kaolin 5 % spray no irrigation respectively. It was attributed due to enhancement of yield attributes of urdbean due to moisture conservation practices. Chhetri et al. [5] corroborated these findings.

3.5 Seed and Stover Yield of Mustard

The grain yield and stover yield of mustard were found significantly maximum under straw mulch treatment (2558 kg grain and 5401 kg stover yield /ha). Life saving irrigation, straw mulch and kaolin 5% spray enhancement grain yield by 94 kg (4.19 %), 312 kg (13.89 %) and 47 kg/ha (2.09%) and stover yield 198 kg (4.18%), 659 kg (13.90%) and 99kg (2.09%) over no irrigation, respectively. It was due to beneficial role of moisture conservation practices on growth and yield of mustard. These results are in conformity with Singh and Rana [6], Roger et al. [7], Awasthi et al. [8], Kumar et al. [9] and Tomboli et al. [10].

3.6 Mustard Equivalent Grain Yield

Results showed in Table 2 that greengram-mustard and urdbean – mustard produced significantly higher mustard equivalent grain yield but maximized (3759kg/ha) under greengram- mustard system. It was probably due to higher seed yield of greengram. Among the moisture conservation practices, significantly highest mustard equivalent grain yield was found in straw mulch treatment (4021 kg/ha). Life saving irrigation, straw mulch and kaolin 5 % spray had more mustard equivalent yield to the tune 148 kg, 492 kg and 75 kg/ha over no irrigation, respectively. It was due higher yield of sesame /greengram/ urdbean/mustard on moisture conservation practices.

3.7 System Production Efficiency

It is evident from Table 2 that significantly maximum production efficiency of 33.52 kg/ha/day was recorded under greengram – mustard system from sesame – mustard and urdbean – mustard. It was also due to higher grain yield of greengram and mustard than other systems of mustard. As regards the moisture conservation practices, the highest system production which was statistically superior over no irrigation, life saving irrigation and kaolin 5% spray. It was might be higher seed yield of sesame /greengram/urdbean/ mustard under straw mulch treatment.

3.8 System Profitability

Data (Table-2) vividly showed that profitability of greengram- mustard was significantly maximum (Rs 339.0 /ha/day) which was statistically higher than sesame – mustard and urdbean – mustard. It was might be due to higher gross and net returns which was the resultant of higher grain yield of greengram and mustard. Significantly highest system profitability was earned in straw mulch treatment (Rs 342.0 /ha/day) which was higher than no irrigation, life saving irrigation and kaolin 5 % spray. It was supported by higher net returns obtained under moisture conservation practices in comparison to no irrigation.

3.9 Economics of the Systems

It is clear from Table 3 that greengram – mustard system with straw mulch earned maximum gross returns (Rs 182764/ha), net returns (Rs 139644/ha) and benefit : cost ratio (3.24) followed by greengram –mustard system in life saving irrigation which gave Rs 166757 /ha gross returns, Rs 121317/ha net returns and 2.67 benefit : cost ratio. It was due to more grain yield, less increase in cultivation cost than increase in gross returns of all tested crops. Kumar et al. [8] supported the findings.

4. CONCLUSION

On the basis of two years experimentation conducted at Mahatma Gandhi Gramodaya Vishwavidyalaya, Chitrakoot, Satna, (M.P.) on sandy loam soils of Bundelkhand region, it may be concluded.

All moisture conservation practice performed better yield of mustard as compared to no irrigation in all cropping system. Use of straw mulch produced maximum seed yield of mustard (2558 kg/ha) in green gram- mustard system. This system produced highest mustard equivalent seed yield of 3759 kg/ha and production efficiency of 33.52 kg grain/ha/day.

Among moisture conservation practices, the maximum gross returns, net returns and benefit: cost ratio was obtained under straw mulch treatment in all the system of cropping (sesame – mustard, green gram- mustard and urdbean-mustard). The highest gross returns of (Rs182764/ha), net returns (Rs.139644/ha) and benefit: cost ratio (3.24) was earned in green gram -mustard system with moisture conservation through straw mulch. This system

also had maximum production profitability of (Rs. 383/ha/day).

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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