# Effect of herbicide application on weed dynamics in pigeon pea based cropping system under rainfed situations of Madhya Pradesh ~~Effect of herbicidal treatment on weed dynamics of pigeon pea based intercropping system in rainfed condition of Kymore Plateau Madhya Pradesh~~


## Abstract

A field experiment was conducted to evaluate the role of intercrops in respect of weed suppression and chemical methods for effective weed control in pigeon pea and green gram based intercropping systems. Results revealed that the relative density of dicot weeds was lower than the relative weed density of monocot weeds and did not show any significant effect on weed dynamics of pigeon pea and green gram based intercropping systems whereas, the application of Pendimethelin @ 1.0 kg ai + Imazethapyr @0.1 kg ai/ha significantly minimum weed density, weed dry weight and maximum weed control efficiency recorded compared to weedy plot at 25, 50 and 75 days after sowing (DAS). This might be due to reduction in weed competition.



***Keywords***: Herbicide, intercropping, weed dynamics, pigeon pea.


## Introduction

Pigeon pea is one of the most important grain legume crops grown in tropical and subtropical areas. It is primarily grown in rainfed environments. Because pigeon peas are long-duration crop, intercropping is used to best utilise available water and land resources, increase risk tolerance, and enhance cost-benefit ratio. The system is now designed to utilise production resources efficiently, increase productivity per unit, and provide stability under challenging climatic conditions. The basic goal of intercropping is to maximise overall productivity per unit of space and time while also making wise and equitable use of available resources, such as labour and land. In addition to these, sole pigeonpea suffers from a heavy weed infestation during the first eight weeks after sowing due to wide row and plant-to-plant spacing, the crop's poor early growth, frequent rains, and insufficient sunlight during the kharif season. During the first 60 days of its growth, the pigeonpea is particularly susceptible to weed competition, as it is a poor weed competitor. It is a wide-row crop that, due to the inadequate canopy cover during the initial growth stage, permits weeds to grow quickly and spread.

~~Pigeon pea is one of the major grain legume crops of the tropical and subtropical regions. It is grown predominantly under rainfed conditions. Intercropping in India is mainly confined to rainfed cultivation. The merit of this system is to serve as kind of insurance against crop~~

~~failure and increasing the risk bearing ability. Hence to setup the production level years after year and obtain maximum cost benefit ratio, optimum utilization of land and water resources by adopting efficient cropping system is of almost importance to meet challenge of population explosion. It is a pre dominant tenure of the dryland farming system of the semi arid topics. Over 50 per cent of the rainfed crops in Asia, Africa and Latin America which are grown under mixed intercropping system. In the recent past however, the consent of intercropping has changed. Now the system is geared to make efficient use of production resources, enhance per unit productivity and provide stability under adverse climatic condition.~~

~~The main concept of intercropping is to get increased total productivity per unit area and time, besides equitable and judicious utilization of land resources and farming inputs including labour. One of the main reasons for higher yield in intercropping is that the component crops are able to use growth resources differently and make better overall use of growth resources than grown separately (Willey, 1979). Sole pigeonpea gets heavily infested with weeds due to wide row and plant to plant spacing, slow early growth of crop and frequent rains and inadequate sunlight during kharif season. The critical period is during the first eight weeks after sowing. Losses in grain yield caused by the weeds in pigeonpea are reported to the extent of 68 per cent in the peninsular zone. (Talnikar et al., 2008). Pigeonpea is a poor weed competitor and is very sensitive to weed competition during the first 60 days of its growth. It is a wide row planted crop and allows weeds to grow vigorously and multiply because of the poor canopy cover during the initial growth period. Emergence of weeds in pigeonpea begins simultaneously with the crop leading to severe weed competition right from the very early stages.~~

Due to its shorter growing period, low water requirement, and low soil fertility as well as its preferred for eating, green gram may be one of the suitable crops for intercropping with pigeon pea~~Greengram is most essential pulse crop in India because of its shorter growth duration, low water demand, low soil fertility and is privileged for consumption due to its soft digestibility and low yield of flatulence~~ (Dhandayuthapani, 2015). With this view, present field experiment was undertaken with objectives to assess the role of intercrops in respect of weed suppression and compare non chemical and chemical methods for effective weed control in pigionpea based intercropping system~~s~~.

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**Materials and Methods**

The field experiment was conducted at the Rajoula Research Farm, M.G.C.G.V(full name)., Chitrakoot, Satna (M.P.) during *kharif* and *rabi* season of 2012-13. The experimental soil was sandy loam having ~~fertility~~ NPK status~~states~~ of 120 kg N, 15 kg $P_2O_5$ and 291 kg $K_2O$/ha with electrical conductivity 0.20 ds/m and soil pH 7.46 ~~were estimated by alkaline potassium permanganate method~~ (Subbiah and Asija 1956~~),~~ Olsen's method (;Olsen et al. 1954~~) and 1 N NH4OAc (~~;Hanway and Heidal, 1952),~~ combined glass electrode pH meter method~~

~~respectively~~. The treatments comprised two cropping systems (sole pigeonpea and pigeonpea + green gram 2:2 row ratio) the main plots and six weed management practices (weedy check, pendimethalin 1 kg ai/ha PE, oxyflyorfen 0.2 kg ai/ha PE, imazethapyr 0.1 kg ai/ha, postemer, pendimethalin + in azethapyr and oxyfluorfen + imazethapyr) in the sub-plots. The twelve treatment combinations were laid out in split plot design with three replications. Pigeon pea "ICPL 88039" and green gram "Samrat" were sown on 21 July 2012 keeping row to row 60 and 20 cm, and plant to plant 20 and 10 cm., respectively. The fertilizers were applied @ 20: 60: 20 kg N: $P_2O_5$: $K_2O$/ha for both the crops or seasons (plz confirm).

The observations on population of major weeds and other associated weeds were recorded at 25, 50 and 75 days after sowing by quadrate count method. The quadrate of $1m^2$ (1mx 1m) was randomly thrown at four places in each plot species wise weed count and total number of weeds $m^2$ were recorded. The percentage composition of weed flora was estimated from weedy check. The relative density of weeds was worked out as per formula at 25 DAS.

$$\text{Relative density (\%)} = \frac{\text{Number of individuals of the same species X 100}}{\text{Number of individuals of all species}}$$

*Weed dry matter*

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Dry weight was worked out by placing a quadrate of $1m^2$ at four places randomly in each plot weed species were removed outside of the net area of each plot at 75 DAS. The weeds were kept in paper bags species wise and dried in oven at oven drying ($70 \pm 1^0$C) and weighted after 48-54 hours till the constant weight was achieved. Dry weight was recorded on electronic balance in $g/m^2$

*Weed control efficiency*

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The total weed biomass obtained before harvest was utilized to determine the weed control efficiency of various treatment using the following formula.

$$\text{Weed Control Efficiency (WCE)} = \frac{W_0\text{-}W_1 \text{ X } 100}{W_0}$$

Where:-

$W_0$ = Weeds dry weight in control weedy plots (g)

$W_1$ = Weed dry weight in treated plots (g)

**Results and discussion**

*Associated weed flora*

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The weed flora ~~asscociated~~associated with the crops are found in experimental field is shown in table-1 according to their botanical names, family and nature of cotyledons. *Amongst monocots, Cyperus rotundus* L (perenial Sedge)*; Cynodon dactylon* (grassy weed) were observed in the experimental area. The associated annual dicot weeds were *Convolvulus arvensis* (perenial) also observed. Such associated weed problems might be because of the experimental field was fallow during past season and this favours the growing of kharif and rabi sedgse and other propagules growing weeds (eg. *Cyprus routundus, cynodon dactylen* etc.). Similar weeds were also found by (Bhalla *et al.*, 1998, Sukhadia *et al.*, 2000 and Tomar *et al.*, 2007).

**Table:1 Associated weed flora at 25 DAS**

| S. No. | English Name | Botanical Name | Family |
|---|---|---|---|
| | **Monocot Weeds** | | |
| 1. | Johnson Grass | *Sorghum halepense* | Poaceae |
| 2. | Doob Grass | *Cynodon dactylon* | Graminae |
| 3. | Nutgrass/ purple nut sedge | *Cyprus rotundus* L. | Cypraceae |
| 4. | Sanwa grass | *Echinocloa spp.* | Poaceae |
| 5. | Swollen finger grass | *Chloris barbata* | Poaceae |
| | **Dicot weeds** | | |
| 1. | Field bind weed | *Convolvulus arvensis* L. | Convolvulaceae |
| 2. | Jangli Gobhi | *Launea Asplenpfolia* | Compositae |
| 3. | Pig weed | *Amaranthus virdis* | Amaranthaceae |
| 4. | Chaff plant | *Digera arvensis* | Amaranthaceae |

***Weed population and relative weed density*** ~~***WEED POPULATION AND RELATIVE WEED DENSITY (%)***~~

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Pigeon pea and green gram faced the problem of both types of weeds viz. monocot (grassy) as well as dicot weeds during crop season. Total weed population and relative density of weedy control plots at 25, 50 and 75 DAS are presented in table -2. Perusal of the data revealed that monocot and dicot both weeds dominating during early crop season. The population of grassy weeds was 105.24/$m^2$ while dicot weeds were to the magnitude of

79.67/$m^2$ at 25 DAS. The relative density of dicot weeds was lower than the relative weed density of monocot weeds. Among the monocot weeds, the highest relative density was noted in *Echinocloa spp.* (31.41 %), *Cyprus rotundus* L (12.18 %) and lowest in *Sorghum halepense* (3.00 %). Among the dicot Weeds, *Digera arvensis* (22.65 %) had the highest relative density followed by *Convolvulus arvensis* L. (8.84 %) and it was lowest was in case of *Amaranthus virdis* (4.75 %). The primary stage of slow growing nature, long and short height of pigeon pea and green gram may be responsible for the weed infestation. Similar observation was also noted by Dangi (2012).

**Table: 2 Composition of weed flora (weedy control plot) expressed in terms of relative density (%) at 25, 50 and 75 DAS**

| S. No. | Weed species | 25 DAS | | 50 DAS | | 75 DAS | |
|---|---|---|---|---|---|---|---|
| | | Weed population / $m^2$ | Relative density (%) | Weed population / $m^2$ | Relative density (%) | Weed population / $m^2$ | Relative density (%) |
| | **Monocot Weeds** | | | | | | |
| 1. | *Sorghum halepense* | 5.54 | 3.00 | 7.55 | 4.48 | 20.98 | 13.15 |
| 2. | *Cynodon dactylon* | 11.52 | 6.23 | 10.35 | 6.14 | 19.85 | 12.45 |
| 3. | *Cyprus rotundus* L. | 22.53 | 12.18 | 21.52 | 12.77 | 21.54 | 13.51 |
| 4. | *Echinocloa spp.* | 58.11 | 31.43 | 41.2 | 24.45 | 21.54 | 13.51 |
| 5. | *Chloris barbata* | 7.54 | 4.08 | 10.65 | 6.32 | 20.44 | 12.82 |
| | **Dicot weeds** | | | | | | |
| 1. | *Convolvulus arvensis* L. | 16.34 | 8.84 | 20.98 | 12.45 | 11.12 | 6.97 |
| 2. | *Commelina bengalensis* | 12.65 | 6.84 | 10.98 | 6.52 | 13.54 | 8.49 |
| 3. | *Amaranthus virdis* | 8.79 | 4.75 | 9.56 | 5.67 | 17.34 | 10.87 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 4. | *Digera arvensis* | 41.89 | 22.65 | 35.69 | 21.18 | 13.14 | 8.24 |
| | **Total** | **184.91** | **100.00** | **168.48** | **100.00** | **159.49** | **100.00** |

~~***TOTAL WEED POPULATION/M$^2$***~~ ***Total weed population***

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Weed control measure significantly affected to the weed density/m$^2$ of pigeon pea and green gram field (Appendix II). A perusal of data table-3 revealed that higher number of weeds/m$^2$ was recorded during early stage of crop and it decreases with advancement in age of crop growth. At 25 DAS, weed density/m$^2$ was lowest in those treatments which had applied $W_5$: Pendimethalin @ 1.0 kg ai + Imazethapyr @0.1 kg ai/ha gradually lower at 50 and 75 days stages of crop while, the weed density of control plot was higher till 90 days crop stages, while, Maximum values were observed in control. This might be due to reduction in weed competition. The above finding confirmed with the results of Ahuja and Cheema (1983), Ahuja *et al.*, 1998, Shrivsatava *et al.* (2001), Patil and Pandey (1996) and Hemlata and Dewangan (2012).

**Table:3 Effect of intercropping and weed management practices on weed density**

| **Treatment** | **Weed density (no. of weeds/m$^2$)** | | |
|---|---|---|---|
| | **25 DAS** | **50 DAS** | **75 DAS** |
| **Cropping system** | | | |
| $I_1$: sole pigeon pea | 57.56 | 64.61 | 99.33 |
| $I_2$: pigeon pea + green gram (2:2) | 53.39 | 57.78 | 99.28 |
| **SEm ±** | **0.77** | **1.43** | **9.63** |
| **CD (P=0.05)** | **NS** | **NS** | **NS** |
| **Weed management** | | | |
| $W_1$: Weedy check | 189.33 | 180.83 | 163.50 |
| $W_2$: Pendimethalin @ 1kg ai/ha | 36.17 | 53.67 | 146.50 |
| $W_3$: Oxyfluorfen @ 0.2 kg ai/ha PE | 43.67 | 53.00 | 112.17 |
| $W_4$: Imazethapyr @ 0.1 kg ai/ha | 24.33 | 29.50 | 87.17 |

| | | | |
|---|---|---|---|
| $W_5$: Pendimethelin @ 1.0 kg ai + Imazethapyr @0.1 kg ai/ha | 15.83 | 13.83 | 39.67 |
| $W_6$: Oxyfluorfen @ 0.2 kg ai/ha PE + Imazethapyr @0.1 kg ai/ha | 23.50 | 36.33 | 46.83 |
| **SEm ±** | **1.93** | **9.70** | **18.01** |
| **CD (P=0.05)** | **5.68** | **28.60** | **53.13** |

~~***TOTAL DRY MATTER OF WEEDS (G/M$^2$)***~~***Total dry matter of weeds***

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Weed dry matter (g/m$^2$) of pigeon pea + green gram field was significantly affected due to various weed control measures at all the stages of crop. Weed dry matter increased with advancement in age of the crop growth i.e. up to 50 days stage. Thereafter, it reduced with the crop age table - 4. At 75 days stage, the weed dry weight reduced probably due to lower weed density and crop shedding effect on weed growth. The results showed that maximum weed dry matter in control plot (177.83, 243.83 and 186.67 g) and minimum weed dry matter in $W_5$: Pendimethelin @ 1.0 kg ai + Imazethapyr @0.1 kg ai/ha (2.34, 15.04 and 11.63 g) at all the stage crop. Weed dry matter (gram/m$^2$) was significantly affected by different weed management practices at 25, 50 and 75 DAS. Shrivsatava *et al.* (2001) reported that application of Pendimethalin significantly reduced the weed population and weed dry weight compare to weedy control, while Nirala *et al.*, 2012 and Hemlata and Dewangan (2012) found the positive effects of weedicide Imazethapyr in controlling weeds.

**Table:4 Effect of weed management and intercropping practices on weed dry matter**

| **Treatment** | **Weed dry matter (g)** | | |
|---|---|---|---|
| | **25 DAS** | **50 DAS** | **75 DAS** |
| **Cropping system** | | | |
| $I_1$: sole pigeon pea | 58.61 | 127.56 | 94.39 |
| $I_2$: pigeon pea + green gram (2:2) | 51.33 | 101.06 | 103.61 |
| **SEm ±** | **1.68** | **11.14** | **5.44** |
| **CD (P=0.05)** | **NS** | **NS** | **NS** |
| **Weed management** | | | |
| $W_1$: Weedy check | 177.83 | 243.83 | 186.67 |

| | | | |
|---|---|---|---|
| $W_2$: Pendimethalin @ 1kg ai/ha | 37.67 | 107.67 | 148.00 |
| $W_3$: Oxyfluorfen @ 0.2 kg ai/ha PE | 48.00 | 156.00 | 105.17 |
| $W_4$: Imazethapyr @ 0.1 kg ai/ha | 24.33 | 64.33 | 77.67 |
| $W_5$: Pendimethelin @ 1.0 kg ai + Imazethapyr @0.1 kg ai/ha | 14.50 | 28.00 | 34.50 |
| $W_6$: Oxyfluorfen @ 0.2 kg ai/ha PE + Imazethapyr @0.1 kg ai/ha post emergence | 27.50 | 86.00 | 42.00 |
| **SEm ±** | **2.34** | **15.04** | **11.63** |
| **CD (P=0.05)** | **6.91** | **44.38** | **34.32** |

*Weed control efficiency*

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Weed control efficiencies under different treatments was worked out and the analyzed data are presented in table-5. The data showed that the weed control efficiency under different intercropping treatment was statistically non-significant, but it was significantly affected by various weed management practices. Among the weed management practices, the weed control efficiency of (91.93, 87.4 and 80 per cent) were recorded highest under $W_5$: Pendimethelin @ 1.0 kg ai + Imazethapyr @0.1 kg ai/ha at 25, 50 and 75 DAS, respectively followed by $W_4$: Imazethapyr @ 0.1 kg ai/ha at 25 and 50 DAS, while it was recorded maximum with $W_6$: Oxyfluorfen @ 0.2 kg ai/ha PE + Imazethapyr @0.1 kg ai/ha at 75 DAS.

**Table: 5 Weed control efficiency under different cropping system and weed management practices**

| Treatment | Weed control efficiency | | |
|---|---|---|---|
| | **25 DAS** | **50 DAS** | **75DAS** |
| **Cropping system** | | | |
| $I_1$: sole pigeon pea | 68.36 | 42.24 | 39.24 |
| $I_2$: pigeon pea + green gram (2:2) | 69.79 | 61.38 | 49.70 |
| **SEm ±** | **0.70** | **7.01** | **4.40** |
| **CD (P=0.05)** | **NS** | **NS** | **NS** |
| **Weed management** | | | |
| $W_1$: Weedy check | 0.00 | 0.00 | 0.00 |
| $W_2$: Pendimethalin @ 1kg ai/ha | 78.75 | 52.79 | 18.23 |
| $W_3$: Oxyfluorfen @ 0.2 kg ai/ha PE | 72.82 | 34.22 | 38.45 |

| | | | |
|---|---|---|---|
| $W_4$: Imazethapyr @ 0.1 kg ai/ha | 86.36 | 73.33 | 55.71 |
| $W_5$: Pendimethelin @ 1.0 kg ai + Imazethapyr @0.1 kg ai/ha | 91.93 | 87.40 | 80.00 |
| $W_6$: Oxyfluorfen @ 0.2 kg ai/ha PE + Imazethapyr @0.1 kg ai/ha post emergence | 84.60 | 63.12 | 74.44 |
| **SEm ±** | **0.88** | **5.97** | **4.71** |
| **CD (P=0.05)** | **2.61** | **17.61** | **13.88** |

Such higher weed control efficiencies might be due to use of integration of pre and post emergence weedicides for weed control. Similar findings were also reported by Shrivsatava *et al*. (2001) and Nirala *et al*., 2012.

**Table:6 Effect of weed management and intercropping practices on seed yields of pigeon pea and green gram**

| Treatment | Seed yield of pigeon pea (kg/ha) | Seed yield of green gram (kg/ha) |
|---|---|---|
| **Cropping system** | | |
| $I_1$: sole pigeon pea | 1136.68 | 0.00 |
| $I_2$: pigeon pea + green gram (2:2) | 1119.67 | 738.09 |
| **SEm ±** | **9.65** | **15.59** |
| **CD (P=0.05)** | **NS** | **17.92** |
| **Weed management** | | |
| $W_1$: Weedy check | 917.70 | 535.18 |
| $W_2$: Pendimethalin @ 1kg ai/ha | 1151.38 | 796.29 |
| $W_3$: Oxyflorfen @ 0.2 kg ai/ha PE | 1027.08 | 544.29 |
| $W_4$: Imazethapyr @ 0.1 kg ai/ha | 1034.37 | 698.14 |
| $W_5$: Pendimethelin @ 1.0 kg ai + Imazethapyr @0.1 kg ai/ha | 1326.73 | 979.62 |
| $W_6$: Oxyflorfen @ 0.2 kg ai/ha PE + Imazethapyr @0.1 kg ai/ha post emergence | 1311.80 | 874.99 |
| **SEm ±** | **20.10** | **19.20** |
| **CD (P=0.05)** | **59.28** | **56.65** |

*Seed yield (Kg/ha)*

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Seed yield of pigeon pea sole (11.36.68 kg/ha) was recorded higher than $I_1$: sole pigeon pea (1119.67 kg/ha. In weed management, $W_5$: Pendimethelin @ 1.0 kg ai + Imazethapyr @0.1 kg ai/ha (1126.77 kg/ha) gave significantly higher seed yield than rest of weed management treatments and is at par with $W_6$: Oxyflorfen @ 0.2 kg ai/ha PE + Imazethapyr @0.1 kg ai/ha post emergence (1311.80 kg/ha). Minimum seed yield was recorded in weedy check treatment. This could be ascribed due to greater value of growth parameter i.e. plant height, plant dry weight, nodules/plant and their dry weight and yield attributes, pods/plant. Such trend might be due to better spatial arrangement of pigeon pea under sole as well as inter cropping system with 2:2 row ratios. The row ratio of pigeon pea + green gram could be associated with least completion of main crop pigeon pea with intercrop green gram. Sarma *et al.* (1995), Rao *et al.* (2007). In weed management, these seed yields of pigeon pea were obtained significantly greater under the treatment $W_5$: Pendimethelin @ 1.0 kg ai + Imazethapyr @0.1 kg ai/ha followed by $W_6$: Oxyfluorfen @ 0.2 kg ai/ha PE + Imazethapyr @0.1 kg ai/ha post emergence. The higher seed yield might be due to significantly greater yield attributes and better growth environments. Such enhancement might be due to least completion between crop plant and weeds which resulted better interception and utilization of radiant energy leading to higher photosynthesis and finally improvement yield of pigeon pea. The results confined to the findings of Hemlata and Dewangan (2012); Shrivsatava *et al.* (2001) and Nirala *et al*., 2012. As there was the crop of green gram was ablsent under treatment $I_1$: sole pigeon pea, the seed yield of green gram was recorded significantly higher as 738.09 kg/ha under the single cropping system treatment compared $I_2$: PP+GG (2:2). Such trend might be due to better spatial arrangement of green gram under intercropped condition with 2:2 row ratios. Pujari and Sheelvantar (2002), Goyal *et al.* (1991) reported the similar findings in their experiments. In weed management treatment, application of $W_5$: Pendimethelin @ 1.0 kg ai + Imazethapyr @0.1 kg ai/ha (979.62 kg/ha) gave significant higher seed yield followed by $W_6$: Oxyfluorfen @ 0.2 kg ai/ha PE + Imazethapyr @0.1 kg ai/ha (874.99 kg/ha). Significantly minimum values were obtained under in weedy check treatment (535.18 kg/ha). The seed yield under $W_5$ and $W_6$ was recorded 83.04 and 63.49 per cent higher as compared to the seed yield obtained under $W_1$: Weedy check. This increase might be due to lower crop weed completion that favours better crop growth and make available more space for crops. Similar are the findings reported by Aziz and Rahman (1995).

**Conclusion**

On the basis of results obtained from the experiment, ~~It~~ it can be concluded that weed can be managed efficiently by application of the pre-emergence weedicide such as Pendimethelin @ 1.0 kg ai with post emergence weedicide Imazethapyr @0.1 kg ai/ha ($W_5$) or by pre-emergence weedicide Oxyfluorfen @ 0.2 kg ai/ha with post emergence weedicide Imazethapyr @ 0.1 kg ai/ha (($W_6$). These weedicides were found efficient in controlling weeds and in relation to higher yield attributes, seed and straw yield of pigeon pea and green gram and gross return, net return of pigeon pea and green gram.

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