International J. Seed Spices 2(2), July 2012:19-26

Organic seed production of cumin (*Cuminum cyminum* L.) with foliar application of *Panchgavya* and plant leaf extracts in arid western rajasthan

Sunil S. Mahajan, R. N. Kumawat and R. S. Mertia

Regional Research Station, CAZRI, Jaisalmer - 345001

ABSTRACT

A field experiment on organic seed production of cumin (*Cuminum cyaminum* L.) was conducted under irrigated conditions at CAZRI, RRS, Jaisalmer, Rajasthan with foliar application of *panchgavya* and plant leaf extracts of neem (*Azadiracta indica*), datura (*Datura metel*) and tumba (*Citrullus colocynthis*) during *rabi* 2006-07 and 2007-08. The results revealed that foliar application of *panchgavya* and plant leaf extracts exhibited significant effects on seed yield, yield attributes and seed quality. Dry matter accumulation, branches per plant, umbels per plant, seeds per umbel, 100-seed weight, seed germination percent and speed of germination (Index) increased significantly with application of neem + *panchgavya*. Compared to control, neem + *panchgavya* increased seed, straw, biological yield and seed germination by 58%, 72%, 65% and 14.67%, respectively. Application of foliar sources both at branching and flowering stages recorded significantly higher accumulation of dry matter, seed yield and yield attributes and seed quality compared to single application at branching or flowering. However, vigour indices such as coefficient of velocity of germination and mean germination time were non-significant.

Key words : Cumin, organic seed production, *panchgavya*, plant leaf extracts, seed yield and quality.

INTRODUCTION

Cumin commonly known as *Jeera* (*Cuminum cyminum* L.) is grown extensively in Rajasthan and Gujarat during *rabi* season and together accounts for over 85% of the total production of cumin seed. Out of which Rajasthan state alone contribute around 52% of the total national production. It covers and contribute 1.5 lakh ha area and 23666 tons production in the state respectively (Anonymous, 4). Cumin is an important condiment and most valued spices grown in India. Cumin seeds and oils are used in culinary preparations for flavouring vegetable, pickles, soup, sauces, cheese and seasoning of breads, cakes and biscuits (Behera and Rao, 5). It is also valued for its typical pleasant aroma from its volatile or essential oil (2.3 to 4.8%) (Agrawal and Sharma, 1). Apart from its culinary value, cumin is also extensively used in ayurvedic medicines and play an important role in national economy as well as domestic and international trade. The demand is increasing by the consumers for quality products and premium price of organic produce in national and international market. Moreover, with the implementation of National Programme on Organic Agriculture (NPOA), use of organic seed/ planting materials for organic crops produce may become mandatory in near future. In view of the new regulations requiring organic seed sources for organically labeled produce, there is a need to switch from intensive chemical based cropping system to organic cultivation of cumin which will not only help in yield stability but also earn higher foreign exchange from the export. There is a wide scope to improve and increase the cumin seed production organically by enhancing the knowledge and adoption of recommended cumin cultivation practices among the farmers. The need of the hour is to develop technology packages for organic seed production and availability of organic seed in the context of varied agroclimatic conditions of the country. However, information on crop specific, location specific organic package of practices for cumin is not adequately available in India.

Agro climatic conditions in arid region of western Rajasthan are very much conducive for cumin seed production. The soils are low in soil organic carbon and other available plant nutrients because of prevailing high annual soil temperature (> 22°C), lesser weathering of minerals and low microbial mass. The added organic inputs remain in their original state for years without decomposition in the soils due to lower population of native microbes (Rao & Venkateswarlu 14). In recent years, foliar application of fermented organic fertilizers has been introduced to modern agriculture to produce food with good quality and safety (Galindo *et al*., 6). Role of foliar applied *panchgavya* in production of many plantation crops had

*Corresponding author: Email: sunilsmahajan@rediffmail.com

been well documented in India. There are reports indicating that efficacy of *panchgavya* solution is enhanced with the mixing of endemic plant leaves. In Rajasthan, plants of tumba (*Citrullus colocynthis* L.) and datura (*Datura metel* L.) grow naturally on waste lands producing a lot of biomass which could be utilized for supplying plant nutrients. Besides, these plant species are also being used in the preparation of many agro-pesticides by farmers of the region. However, there is no sufficient information on the effect of *panchgavya* on the growth and seed yield of cumin. Therefore, the present study was conducted to produce cumin seed organically with *panchgavya* along with leaf extracts of neem, datura and tumba through foliar application as the soils of arid regions do not respond much to soil application of organic sources due to low microbial population of the rhizosphere and low mineralization.

MATERIALS AND METHODS

The experiment was conducted at Central Arid Zone Research Institute, Regional Research Station, Jaisalmer (Rajasthan) during *rabi* 2006-07 and 2007-08. The sandy soils of the experimental field was shallow in depth (50 cm) having 0.08% organic carbon, available N, P, K and S was 72.80, 6.45, 252.78 and 6.92 kg/ha, respectively, and 7.55% free CaCO3 with pH 9.2. The leaf-extract of neem (*Azadirachta indica* L.) + *panchgavya*, datura (*Datura metel* L) + *panchgavya*, and tumba (*Citrullus colocynthis* L) + *panchgavya* along with *panchgavya* and control (water spray) were used as sources of foliar application. These sources of foliar applications were applied either at branching (45 days after sowing-DAS) or flowering (65 DAS) and both at branching and flowering stages. *Panchgavya* was prepared by thorough mixing of fresh cow dung (7 kg), cow ghee (1 kg), fresh cow urine (10.0 L), cow milk (3.0 L) and cow milk curd (2.0 L). The leaf extracts of neem, datura and tumba were prepared by mixing fresh ground leaves with cow urine in 1:1 ratio followed by fermentation. The physicochemical properties of soil, *panchagavya* and leaf extract is given in Table 1. The filtrates of leaf extracts were mixed with the filtered *panchgavya* solution in 1:1 ratio for respective leaf extracts. The cumin variety RZ 19 was sown on 25 November 2007 and 20 November 2008 @ 12 kg seed per hectare after applying pre-sowing irrigation. Foliar application of *panchgavya* and plant leaf extracts was done as per treatments after diluting the solutions 30 times with water. The N and P contents in plant parts were determined using established methods of analysis. The germination test was conducted as per standard procedures given by the ISTA (Anonymous, 3). Vigour tests viz., speed of germination, mean germination time and coefficient of velocity of germination was conducted as per Maguire (10), Nichols and Heydecker (12) and Kotowski (8), respectively.

RESULTS AND DISCUSSION

Foliar application of neem + *panchgavya* recorded significantly higher accumulation of plant dry matter among the sources of foliar application (Fig. 1). Application of neem leaf extract + *panchgavya* recorded 30%, 54% and 80% higher plant dry matter compared to control at 55 DAS, 80 DAS and harvest, respectively. Similarly, seed weight/plant increased by 80% with application of neem leaf extract + *panchgavya*. At maturity, application of these sources at branching and flowering recorded significantly higher plant dry matter compared to single spray either at branching or flowering. The significant improvement in the accumulation of dry matter in plant and its distribution in seed was attributed to increased supply of plant nutrients, specific weight of leaf, chlorophyll synthesis, nitrogen metabolism and phytohormones with the application of *panchgavya* and *panchgavya* + leaf extracts (Kumawat *et al*., 9). The supply of N in plant is related to the specific area of leaf (projected leaf surface per unit leaf dry bi-mass) and synthesis of chlorophyll (Khanzada *et al*. 7). Improved nutrition (Table 1) with different sources of nutrients might enable greater leaf area production and greater interception of light thereby increasing dry matter accimulation (Table 1).

Foliar application of *panchgavya* alone and in combination with leaf extracts of neem, tumba and datura increased all the yield attributes as compared to control (Table 2). Application of neem + *panchgavya* recorded 66%, 60%, 31% and 8% higher branches/plant, umbels/plant, seeds/umbel and 100-seed weight respectively than control. A non significant difference however was observed among *panchgavya*, neem + *panchgavya*, datura + *panchgavya* and tumba + *panchgavya* for seeds/umbel. Stages of foliar application had significant effect on yield attributes of cumin. Foliar application at branching and flowering recording significantly higher yield attributes than spray at branching or flowering (Table 2). The dual application of sources recorded 15%, 52%, 74%, 27% and 14% higher plant height, branches/plant, umbels/plant, seeds/umbel and 100-seed weight than foliar application at flowering only. The significant improvement in yield attributes with sources of foliar application was ascribed to increased crop growth of the plant with these sources. Dry matter accumulation per plant showed consistent increase with these sources of application. The increased dry matter might have contributed for higher yield attributes compared to control. The overall higher yield attributes with neem + *panchgavya* might be ascribed to higher nutrient content of the medium solution used in the study compared to other sources.

Seed, straw and biological yields increased significantly with foliar application of neem + *panchgavya*, datura + *panchgavya* and tumba + *panchgavya* treatments compared to control and application of *panchgavya* alone (Fig. 2-4). However, neem + *panchgavya* was significantly

Table 1. Physicochemical properties of soil, panchgavya and plant leaf extracts

Physicochemical properties	Soil of experimental field	Panchgavya	Neem	Datura	Tumba
pH	9.20	4.35	4.39	4.00	5.42
EC (dS/m)	-	19.36	33.70	34.2	34.90
OC content (%)	0.05	1.50	1.90	1.67	1.60
N content (ppm)	32.35	5800	10500	8600	8300
P content (ppm)	2.86	900	7800	7600	3900
K content (ppm)	95.90	-	-	-	-
S content (ppm)	3.08	-	-	-	-
$CaCO_3$ content (%)	7.55	-	-	-	-

Table 2. Effect of foliar sources and stages of applications on Dry matter accumulation and yield attributes of cumin (mean of 2 years)

Treatments	Yield attributes of cumin					
	Plant height (cm)	Branches /plant	Umbels/ plant	Seeds/umbel	100 seed weight (mg)	Seed weight/plant (g)
Foliar source						
Control	28.21	5.70	15.47	17.23	376.62	0.88
Panchgavya	30.63	6.82	19.31	22.09	387.50	1.27
Neem	32.71	9.45	24.73	22.65	408.60	1.57
Datura	30.65	7.31	20.52	22.36	388.38	1.40
Tumba	33.31	8.24	22.57	22.56	396.62	1.40
SEm±	0.32	0.16	0.31	0.25	5.86	0.03
CD at 5%	0.90	0.44	0.87	0.70	16.61	0.08
Stages of Application						
Branching	31.32	7.40	20.17	21.63	384.92	1.22
Flowering	28.77	6.00	16.57	18.72	368.84	1.08
Branching+Flowering	33.21	9.10	24.82	23.79	420.88	1.61
SEm±	0.25	0.12	0.24	0.19	4.54	0.02
CD at 5%	0.70	0.34	0.68	0.54	12.87	0.06

superior among sources of foliar application and recorded 58%, 72% and 65% higher seed, straw and biological yield respectively, compared to control. Application of these plant source extracts at branching and flowering recorded higher biological and seed yield than single spray either at branching or flowering (Fig. 2-4). Combine application of neem + *panchgavya* at branching and flowering recorded significantly higher seed, straw and biological yields among the and their stages of application. The significant improvement in seed and biological yield with all the foliar sources might be associated with increased yield attributes due to concomitant increase in dry matter accumulation, chlorophyll content, nitrate reductase activity and supply of all the plant nutrients (Kumawat *et al*., 9). Natarajan (11) reported that *panchgavya* application increased the yield of crop plants by enhancing the biological efficiency of crop plants. The application of these sources either at branching or flowering may not supply nutrients in sufficient amount for full development of the plants. Hence, higher plant dry matter/ plant and biological and seed yields were observed in the experiment with application of plant leaf extracts +

Table 3. Effect of foliar sources and stages of applications on seed germination and vigour

Treatments	Germination (%)	Speed of germination (Index)	Coefficient of velocity of germination	Mean germination Time (Days)
Foliar source				
Control	80.7	15.03	18.05	5.55
Panchgavya	88.0	16.94	18.50	5.42
Neem	92.5	17.32	18.03	5.55
Datura	88.2	16.80	18.39	5.44
Tumba	87.8	16.50	18.23	5.49
SEm±	0.9	0.24	0.17	0.05
CD at 5%	2.5	0.69	0.49	0.14
Stages of Application				
Branching	83.9	15.75	18.15	5.52
Flowering	88.4	16.66	18.21	5.49
Branching+Flowering	90.0	17.15	18.36	5.46
SEm±	0.7	0.19	0.13	0.04
CD at 5%	1.9	0.54	0.38	0.11

Fig. 1. Effect of foliar sources and their stage of application on dry matter accumulation of cumin (mean of 2 years)

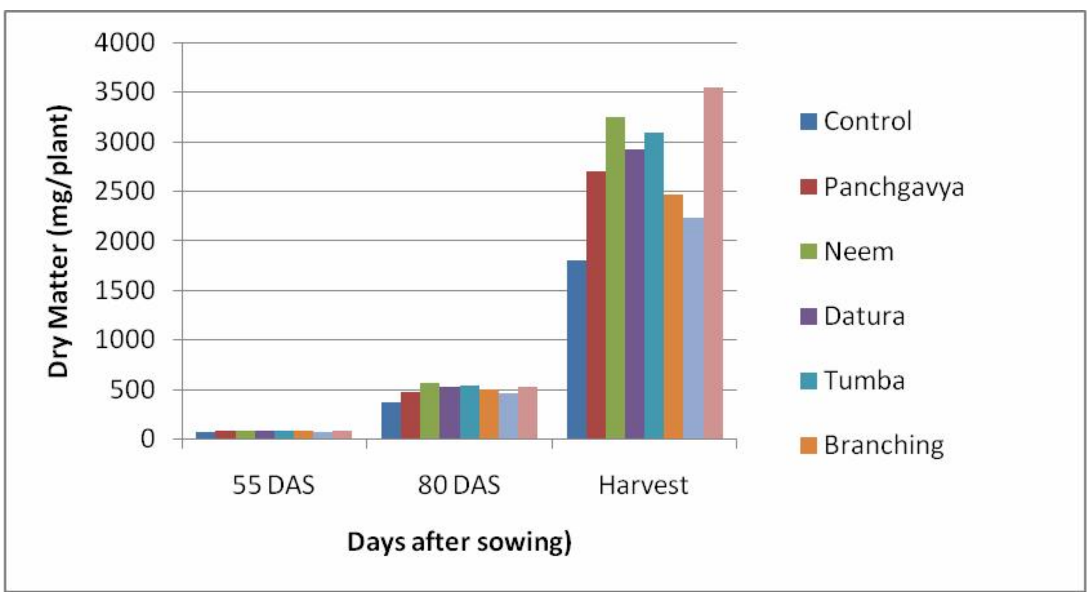


Fig 2. Effect of sources of application at different stages on seed yield of cumin

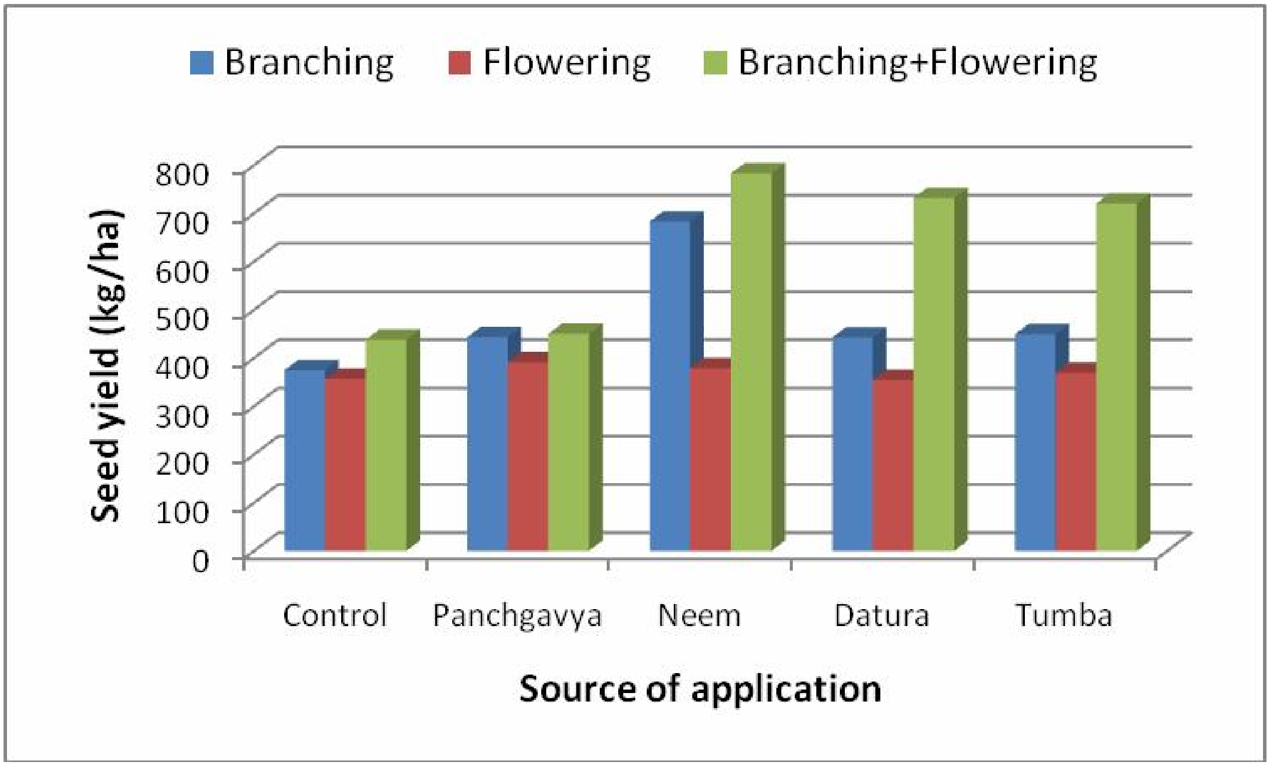


Fig 3. Effect of sources of application at different stages on straw yield of cumin

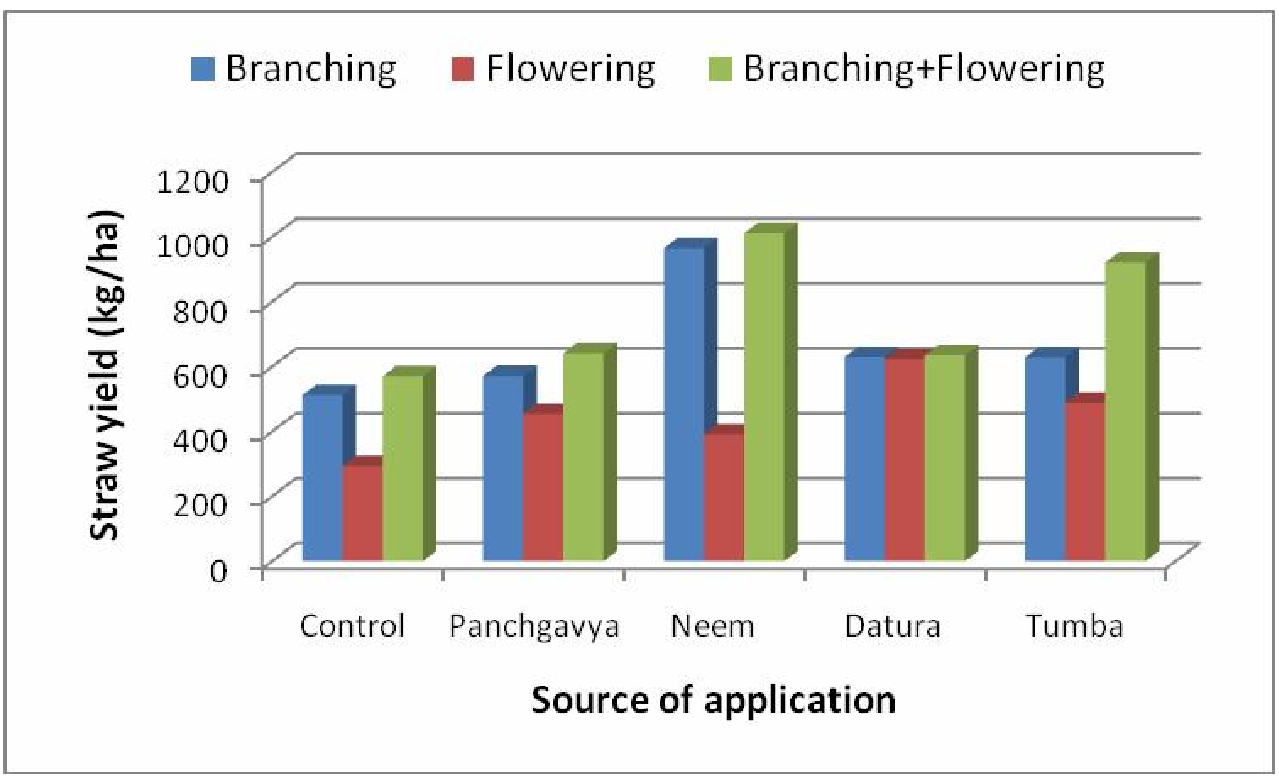


Fig 4. Effect of sources of application at different stages on Biological yield of cumin

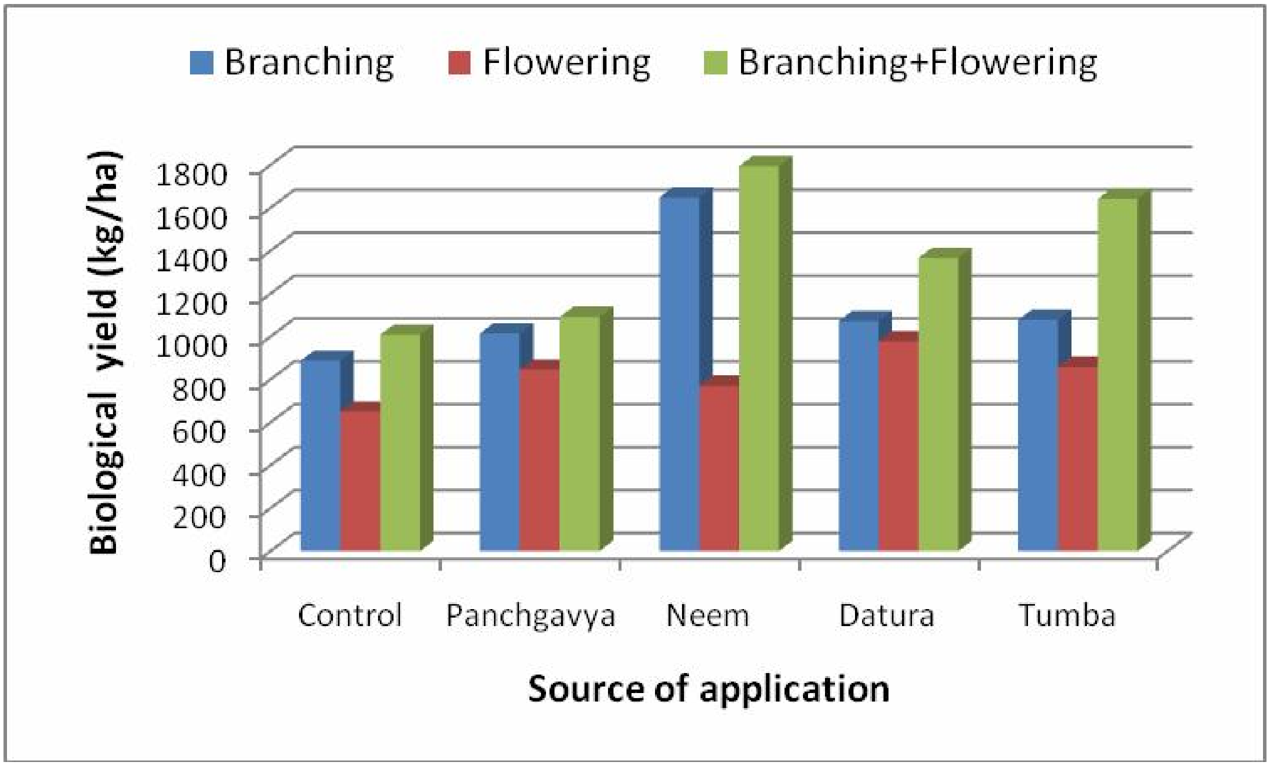


Fig 5. Effect of foliar sources on rate of seed germination of cumin

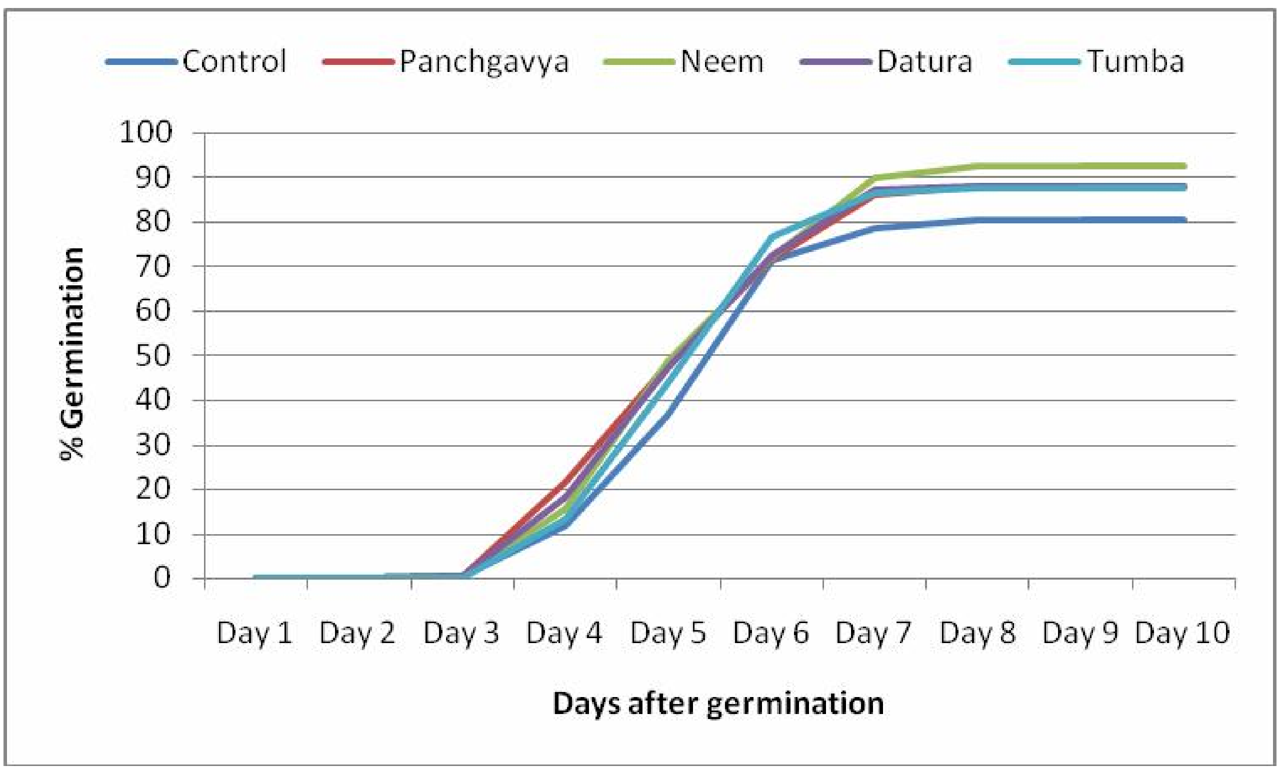
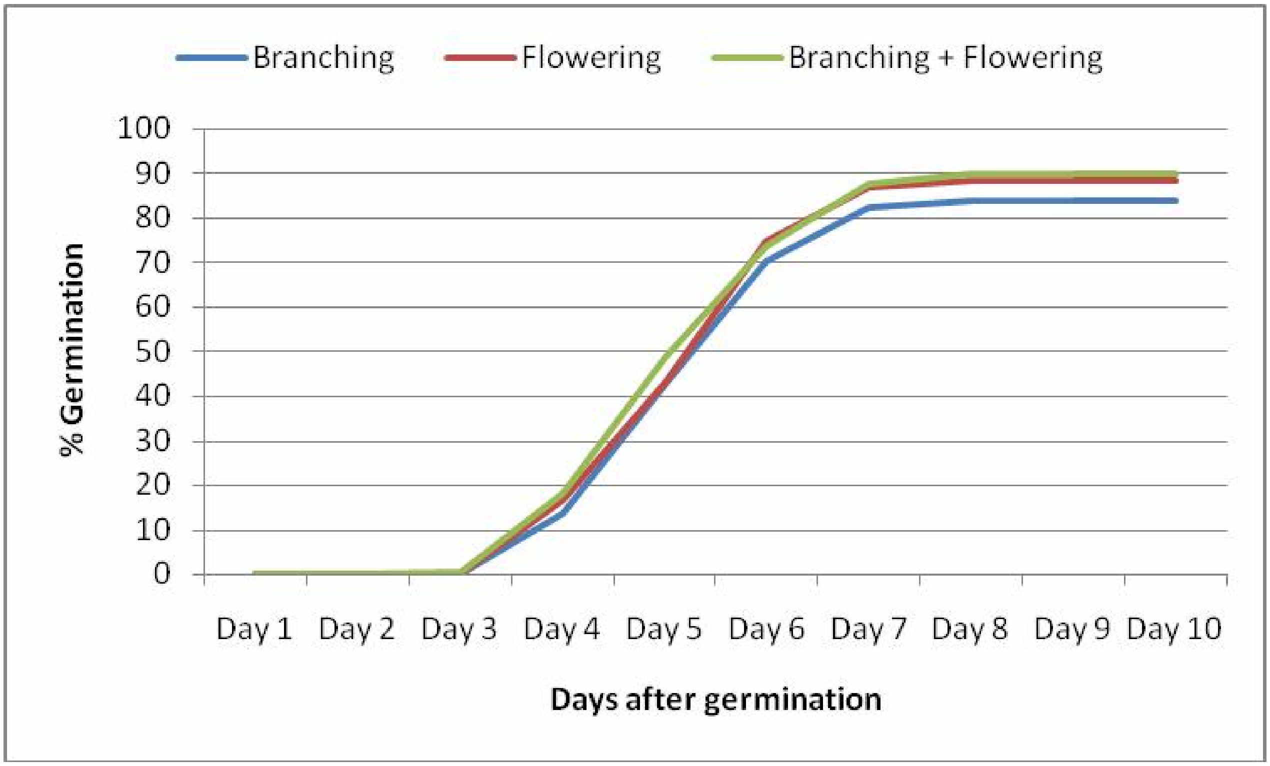


Fig 6. Effect of stages of application on rate of seed germination of cumin



panchgavya both at branching and flowering.

Seed quality of cumin also increased with the foliar application of *panchgavya* and plant leaf extracts. Foliar application of Neem leaf extract + *panchgavya* exhibited significantly the highest seed germination and rate of cumin (Table 3 & Fig. 4). Speed of germination considers the number of germinated seeds between two exposure times; where as accumulated germination involves the cumulative number of germinated seeds at each exposure time (Anjum and Bajwa, 2). This indicated that the improvement of seed quality with these treatments was due to the nutritional status acquired during the plant growth. Dual application of foliar spray had an additional advantage over the single application. Dual application of foliar spray at branching and flowering also had significantly higher seed germination as compared to the single application at branching or flowering. However, vigour indices such as coefficient of velocity of germination and mean germination time were non-significant (Table 3). The speed and pattern of seed germination is indicative of different vigour status of the seed affected by the foliar spray of different sources at different stages (Fig. 4-5).

Finally it is concluded that the vast majority of biomass of underutilized plants can be successfully utilized in agriculture. *Panchgavya* and plant leaf extracts are the cheapest source of plant nutrition available for organic agricultural in desert soils. These sources not only maintain the soil fertility and health status but also enhance the productivity and quality of produce. Neem leaf extracts and *panchgavya* thus can be used for organic agriculture and particularly in seed production of high value crops like cumin.

REFERENCES

1. Agrawal, S. and Sharma, R.K. 1990. Variability in quality aspects of seed spices and future strategy. *Indian cocoa, arecanut and spices journal*, **13**: 127-129.
2. Anjum Tehmina and Bajwa, Rukhsana, 2005. Importance of Germination Indices in Interpretation of Allelochemical Effects. *Int. J. Agric. & Biol.* **7(3)**: 417-419.
3. Anonymous, 1999. International rules for seed testing. *Seed Sci. & Technol.*, (Supplement Rules) **27**: 25-30.
4. Anonymous, 2006-07. Vital Agricultural Statistics, Directorate of Agriculture, Government of Rajasthan.
5. Behera, S.S., Nagarajan and Rao, L.J.M. 2004. Microwave heating and conventional roasting of cumin Seeds *(Cuminum cyminum* L.) and effect on chemical composition of volatiles. *Food Chemistry*. **87(1)**: 25-29.
6. Galindo, A. Jeronimo, C. Spaans, E. and Weil, M. 2007. Los abonos líquidos fermentados y su efectividad en plantulas de papaya (*Carica papaya* L.). *Tierra Tropical* **3 (1):** 91-96.

7. Khanzada, B., Ashraf, M.Y., Shirazi, M. U., Alam, S.M., Samo, K.B. and Mujtaba, S.M. 2003. Study of photosynthetic efficiency of some guar (*Cyamopsis tetragonoloba*) genotypes grown under different water regimes*. Asian J. Plant Sci*. **2:** 127-131.

8. Kotowski, F. 1926. Temperature relations to germination of vegetable seed. *Proc. Am. Soc. Hort. Sci*. **23:** 176-184.

9. Kumawat, R.N., Mahajan, S.S. and Mertia, R.S. 2009. Response of cumin (*Cuminum cyminum* L) to *panchgavya* and plant leaf extracts in arid western Rajasthan. *J. Spices and Aromatic Crops*. **18(2):**92-99.

10. Maguire, J.D. 1962. Speed of germination –aid in selection and evaluation for seedling emergence and vigour. *Crop Sci*. **2:**176-177.

11. Natarajan, K. 2002. Panchakavya-A Manual. Other India Press, Mapusa, Goa.

12. Nichols, M.A. and Heydecker, W. 1968. Two approaches to the study of germination data. *Proc. Int. Seed Test. Assoc*. **33**:531-540.

13. Poorter, H. and Nagel, O. 2000. The role of biomass allocation in the growth response of plants to different levels of light, CO2, nutrients and water: a quantitative review. *Australian J. Plant Physiol.* **27**: 595-607.

14. Rao, A.V. and Venkateswarlu, B. 1983. Mineral ecology of the soils of Indian desert. *Agric. Ecosyst. Environ.* **10**: 361-364.

Received : November 2011; Revised : Feb. 2012; Accepted : May 2012.